Curriculum Vita

Gregory V. Bard

Contact Info

Email bardg@uwstout.edu

Position Tenured Associate Professor of Mathematics
(was Assistant Professor from August 2011–June 2015; awarded tenure in June of 2016)

Institution The University of Wisconsin—Stout
College of Science, Technology, Engineering, and Mathematics.
Department of Mathematics, Statistics, and Computer Science.

Professional Web Page http://www.uwstout.edu/faculty/bardg/

Personal Web Page http://www.gregorybard.com/

Education

Ph.D.	Applied Math and Scientific Computation	University of Maryland at College Park	Aug 2007
M.Sc.	Applied Math and Scientific Computation	University of Maryland at College Park	Dec 2005
	Visiting Student in Mathematics & History	New College, Oxford University, UK	Spring 2004
M.Sc.	Electrical and Computer Engineering	University of Maryland at College Park	May 2002
B.Sc.	Computer and Systems Engineering, *magna*	Rensselaer Polytechnic Institute	May 1999

Research Interests

- Cryptology, Cryptanalysis, and particularly Algebraic Cryptanalysis
- Computer Algebra (e.g. Solving Polynomial Systems of Equations, and applications of the same)
- Linear Algebra over Finite Fields, with applications in Error Correcting/Detecting Codes
- Security Protocols, Proofs of Security, & Practical Implementations
- Operations Research, Optimization, Game Theory, and other applications of Math to Economics

Previous Employment

Employer	Department	Role	Time
University of Waterloo	Symbolic Comput. Group	Visiting Scholar	6/2012
Fordham University	Mathematics	Visiting Assistant Professor	9/2007 – 5/2011
Chinese Academy of Sciences	Inst. for Math. Mechanization	Visiting Professor	7/2010
Intl. University of Monaco	Doctoral Studies	Visiting Professor	9/2009
University of Maryland	Mathematics	NSF Diss. Completion Fellow	8/2006 – 6/2007
ECRYPT	n/a	Invited Visiting Scientist	5/2006 – 8/2006
American University	Computer Science	Lecturer	1/2005 – 5/2006
University of Maryland	Computer Science	Research Assistant	8/2003 – 4/2004
Naval Surface Warfare Ctr	Active Materials	Summer Intern	5/2003 – 8/2003
University of Maryland	Computer Science	Teaching Assistant	1/2003 – 5/2003
National Security Agency	Research Directorate	Comp. Cryptologic Engineer	5/2001 – 9/2002
National Security Agency	Operations Directorate	Comp. Cryptologic Engineer	6/1999 – 5/2001
National Security Agency	Information Sec. Directorate	Summer Intern	5/1998 – 8/1998
Rensselaer Polytechnic Inst.	Elec. & Comp. Sys. Eng.	Undergraduate Researcher	1/1998 – 5/1998
Rensselaer Polytechnic Inst.	Elec. & Comp. Sys. Eng.	Undergraduate Researcher	1/1997 – 5/1997
Hermes Machine Tool	n/a	Web Developer	5/1996 – 8/1996

Teaching Experience

- This list includes all courses up to and including the Fall 2017 semester.
- The University of Wisconsin—Stout (August 2011 to present)
  - Math-123: Finite & Financial Mathematics (six semesters)
  - Math-153: Calculus I (two semesters)
  - Math-154: Calculus II (seven semesters)
  - Math-270: Discrete Mathematics (six semesters)
  - Math-371: Modern Algebra II (once; independent study for one student)
  - MSCS-380: Cryptography (three semesters)
  - MSCS-747: Scientific Computing (once)
  - CS-480/680: Computer Security (four semesters)
- Fordham University (August 2007 to May 2011)
  - Math-1108: Math for Business: Finite (three semesters)
  - Math-1109: Math for Business: Calculus
  - Math-1204: Applied Calculus II
  - Math-1206: Calculus I (three semesters)
  - Math-1207: Calculus II
  - Math-2004: Multivariate Calculus
  - ‡ Math-2021: Cryptography
  - Math-3002: Differential Equations
  - Math-3005: Abstract Algebra
  - ‡ Math-3021: Graph Theory
  - ‡ Math-4006: Numerical Analysis
  - Math-4999: Bachelor's Thesis and/or Indep. Study (four semesters)
  - The courses marked ‡ were cross-listed with the Computer Science major.
- The Chinese Academy of Sciences—Institute for Mathematics Mechanization (Summer of 2010)
  - Algebraic Cryptanalysis II
- International University of Monaco (One week: September 28th to October 2nd, 2009)
  - DOCT-703: Experimental Research, Design & Assessment
- American University (January 2005 to May 2006)
  - CSC-100: Computers and Information
  - CSC-281: Introduction to Computer Science II
  - CSC-544: Object-Oriented Programming
- University of Maryland at College Park (January 2003 to May 2003)
  - Teaching Assistant for CMSC-858K: Introduction to Cryptography (graduate level)

Publications

A listing of the papers from most frequently cited to least, according to Google Scholar on August 31st, 2017, is available at: `http://www.gregorybard.com/papers/citation_list_Aug_31_2017.pdf`

Books

In Preparation: G. Bard. *Discrete Structures in Mathematics—A Problem-Solving Perspective.* Roughly 400 out of 800 pages completed.

On Hold: G. Bard. *Finite & Financial Mathematics.* Roughly 900 out of 1200 pages completed.
`http://www.gregorybard.com/finite.html`

- G. Bard. *Sage for Undergraduates.* The American Mathematical Society. 2015. ISBN: 1-470-41111-3. [Note: 352 pp.]
`http://www.gregorybard.com/books.html`

Note: The American Institute of Mathematics (AIM) placed *Sage for Undergraduates* on its list of "Approved Open-Access Textbooks" judged to meet its strict evaluation criteria. It was the 33rd book to be added to the list. http://aimath.org/textbooks/approved-textbooks/

- G. Bard. *Algebraic Cryptanalysis.* Springer-Verlag. 2009. ISBN: 0-387-88756-3. [Note: 384 pp.]

Patents

Pending: C. Gressel, R. Pinnick, N. Courtois, G. Vago, G. Bard, R. Granot, A. Hecht. *System and Method for Computerized Negotiations Based on Coded Integrity.* Filed July 18, 2013. Published March 13, 2014. Patent Pending. Application No.: US 13 / 945,616.

- C. Gressel, N. Courtois, G. Bard, A. Hecht, R. Granot, T. J. Salmon, I. Mintz. *System and Methods for Encryption with Authentication Integrity.* Filed January 28, 2010. Published August 5, 2010. Awarded October 2, 2012. US Patent No.: 8,280,056.

- C. Gressel, G. Bard, O. Dunkelman, A. Hecht, R. Granot. *System and Method to Preclude Message Modification in Data Authentications Systems through Efficient Use of Feedback in Cryptographic Functions.* Filed Sept 6, 2007. Published March 13, 2008. Awarded October 2, 2012.
US Patent No.: 8,107,622.

Peer-Reviewed Papers

- (For works in progress, see Page 5.)

- Gregory Bard. "An inequality for detecting financial fraud, derived from the Markowitz Optimal Portfolio Theory" Proceedings of the 42nd International Conference on Applications of Mathematics in Engineering and Economics (AMEE'16), Sozopol, Bulgaria. *American Institute of Physics Conference Proceedings*, **Vol. 1789**, No. 1, (V. Pasheva, N. Popivanov and G. Venkov, Eds.), 2016. ISBN: 978-0-7354-1453-2.
`http://www.gregorybard.com/papers/markowitz_fraud_detection_with_appendices.pdf`

- Gregory Bard, Shaun van Ault, and Nicolas Courtois. "Statistics of Random Permutations and the Cryptanalysis Of Periodic Block Ciphers." The journal *Cryptologia.* **Vol. 36** No. 3 (2012), Pp. 240–262, ISSN: 0161-1194.
`http://www.gregorybard.com/papers/courtois_bard_ault.pdf`

- Nicolas Courtois, and Gregory Bard. "Random Permutation Statistics and An Improved Slide-Determine Attack on KeeLoq." *Lecture Notes in Computer Science*, **Vol. 6805**, Pp. 35–54, (David Naccache, Ed.), 2012. ISBN: 3-642-28367-3.
`http://www.gregorybard.com/papers/keeloq_new_paper.pdf`

- Michael Black and Gregory Bard. "SAT Over BOINC: An Application-Independent Volunteer Grid Project." Proceedings of the 12th IEEE/ACM International Conference on Grid Computing (GRID'11), Lyon, France. IEEE Press, Pp 226–227, (Shantenu Jha, Nils Gentschen Felde, Rajkumar Buyya and Gilles Fedak, Eds.), 2011. ISBN: 1-4577-1904-2.
`http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6076480`

- Gregory Bard. "Numerically Estimating Derivatives during Simulations." Proceedings of the 2011 International Conference on Modeling, Simulation, & Visualization Methods (MSV'11). Las Vegas, Nevada. CSREA Press, Pp 341–347, (Hamid Arabnia, Leonidas Deligiannidis, Ashu Solo, and Omer Soysal, Eds.), 2011. ISBN: 1-60132-192-9.
`http://www.gregorybard.com/papers/derivatives.pdf`

- Gregory Bard, Nicolas Courtois, Jorge Nakahara Jr., Pouyan Sepehrdad, and Bingsheng Zhang. "Algebraic, AIDA/Cube and Side Channel Analysis of the KATAN Family of Block Ciphers." Progress in Cryptology (INDOCRYPT'10). Hyderabad, India. *Lecture Notes in Computer Science*, **Vol. 6498**, Pp. 176–196, (Guang Gong and Kishan Chand Gupt, Eds.), 2010. ISBN: 978-3-642-17400-1.
`http://www.gregorybard.com/papers/cube_for_web.pdf`

- Kenneth Wong, and Gregory Bard. "Improved Algebraic Cryptanalysis of QUAD, Bivium, and Trivium via Graph Partitioning on Equation Systems." Proceedings of the Australasian Conference on Information Security and Privacy (ACISP'10). Sydney, Australia. *Lecture Notes in Computer Science*, **Vol. 6168**, Pp. 19–36, (Ron Steinfeld and Philip Hawkes, Eds.), 2010. ISBN: 3-642-14080-7.
`http://eprint.iacr.org/2010/349`

Abstract Only: Gregory Bard. "DEMOCRACY: A Heuristic for Polynomial Systems of Equations over Finite Fields." The journal *ACM Communications in Computer Algebra*. **Vol. 44** No. 1 (2010), Pp. 25–25, ISSN: 1932-2240.
`http://dl.acm.org/citation.cfm?id=1838599.1838613`

Full paper of the above available at:
`http://grim.univ-tln.fr/YACC10/ABSTRACTS/04_bard.pdf`

- Martin Albrecht, Gregory Bard, and Bill Hart. "Algorithm 898: Efficient Multiplication of Dense Matrices over $GF(2)$." *ACM Transactions on Mathematical Software*. **Vol. 37** No. 1 (2009), Pp. 1–14, ISSN: 0098-3500.
`http://www.gregorybard.com/papers/albrecht_bard_hart.pdf`

- Nicolas Courtois, Gregory Bard, and Andrey Bogdanov. "Periodic Ciphers with Small Blocks and Cryptanalysis of KeeLoq." *Tatra Mountains Mathematical Publications*. **Vol. 41** (2008), Pp. 167–188. ISSN: 1210-3195
`http://www.gregorybard.com/papers/keeloq_tatra.pdf`

- Nicolas Courtois, Gregory Bard, and David Wagner, "Algebraic and Slide Attacks on KeeLoq." Proceedings of Fast Software Encryption (FSE'08). Lausanne, Switzerland. *Lecture Notes in Computer Science*, **Vol. 5086**, Pp. 97–115, (K. Nyberg, Ed.), 2008. ISBN 978-3-540-71038-7.
`http://eprint.iacr.org/2007/062`

- Nicolas Courtois and Gregory Bard, "Algebraic Cryptanalysis of the Data Encryption Standard." Proceedings of the IMA International Conference on Cryptography and Coding (IMA-CCC'07). Cirencester, Wales. *Lecture Notes in Computer Science*, **Vol. 4887**, Pp. 152–169, (Steven D. Galbraith, Ed.), 2008. ISBN: 3-540-77271-5.
`http://eprint.iacr.org/2006/402`

- Gregory Bard, "Modes of Encryption Secure Against Blockwise-Adaptive Chosen-Plaintext Attack." Proceedings of the IMA International Conference on Cryptography and Coding (IMA-CCC'07). Cirencester, Wales. *Lecture Notes in Computer Science*, **Vol. 4887**, Pp. 129–151, (Steven D. Galbraith, Ed.), 2008. ISBN: 3-540-77271-5.
`http://eprint.iacr.org/2006/271`

- Gregory Bard, "Spelling-Error and Reordering Tolerant Pass-phrases via the Damerau-Levenshtein String-Edit Distance Metric." Proceedings of the Australasian Information Security Workshop, (AISW'06). Ballarat, Australia. *ACM International Conference Proceeding Series*, **Vol. 249**, Pp. 117–124, (Ljiljana Brankovic, Paul Coddington, John F. Roddick, Chris Steketee, Jim Warren, and Andrew Wendelborn, Eds.), 2007. ISBN: 1-920-68285-X.
`http://eprint.iacr.org/2006/364`

- Gregory Bard, Nicolas Courtois, and Chris Jefferson. "Solution of Sparse Polynomial Systems over GF(2) via SAT-Solvers." Proceedings of the ECRYPT Workshop Tools for Cryptanalysis, (TFC'07). Krakow, Poland. Informally published. (14 pp.), (Jacques Patarin, *et al*, Eds.), 2007.
`http://eprint.iacr.org/2007/024`

- Gregory Bard, "A Challenging but Feasible Blockwise-Adaptive Chosen-Plaintext Attack on SSL." Proceedings of the IEEE-IACR joint International Conference on Security and Cryptography, (SECRYPT'06). Setúbal, Portugal. Pp. 99–109. (Manu Malek, Eduardo Fernndez-Medina, Javier Hernando, Eds.), 2006. ISBN: 972-8865-63-5.
`http://eprint.iacr.org/2006/136`

- Gregory Bard, "FLOWHUNT— An Attempt at Specification-Based Intrusion Detection using Neural Networks." Proceedings of the 2nd Annual Computer Network Exploitation Conference, (CNE'02). (A conference limited to the US Department of Defense and Intelligence Community, and the Ministries of Defense of certain allied nations, but competitive and peer-reviewed. While the proceedings were classified, this paper, however, was not.) 19 pp.
`http://www.gregorybard.com/papers/flowhunt_for_web.pdf`

Working Papers and Works in Progress

Submitted: Gregory Bard. "Uses and Misuses of Bayes' Rule and Bayesian Classifiers in Cybersecurity."

In Preparation: Gregory Bard. "On one-time pads that are used twice."

On Hold: Mark DeBonis and Gregory Bard. "The Interactions between The Veronese Variety and the XL Algorithm of Nicolas Courtois."

Under Revision: Gregory Bard, and David Hagman. "Are We Lying to Our Children? Conflating Real and Nominal Rates of Return in Saving for Retirement." (11 pp.)

Under Revision: Gregory Bard. "Determining Whether a Given Block Cipher is a Permutation of Another Given Block Cipher (a Problem in Intellectual Property)." (12 pp.)
`http://www.gregorybard.com/papers/bard_permuted_block_cipher.pdf`

Under Revision: Gregory Bard, and Alexander Basyrov. "Error Bounds on Derivatives During Simulations." (11 pp.)
`http://arxiv.org/abs/1212.0280`

Under Revision: Kyle Kloster, and Gregory Bard. "Factoring a semiprime n by estimating $\phi(n)$." This will be a revision of the following Bachelor's Thesis.
`http://www.gregorybard.com/papers/phi_version_may_7.pdf`

Under Revision: Gregory Bard. "New Practical Approximate Matrix Multiplication Algorithms found via Solving a System of Cubic Equations." (17 pp.) A draft has been made available. Some numerical experiments still remain to be done, and will take some time.
`http://www.gregorybard.com/papers/early_release.pdf`

Under Revision: Gregory Bard. "Extending SAT-Solvers to Low Degree Extension Fields of GF(2)." (25 pp.)
`http://www.gregorybard.com/papers/extension_fields.pdf`

Technical Reports and Non-Peer Reviewed Papers

See the full 19-page version of this CV, available at
http://www.gregorybard.com/papers/CV_long_form.pdf.

Students & Theses Supervised

- Short summer projects with undergraduates are omitted to save space.
- Joseph Bertino, Mathematics & Economics Double Major at Fordham,
  Bachelor's Thesis defended, May 18, 2011, "Solving Systems of Polynomial Equations Using Gradient Descent and Other Conjugate Gradient Methods, Enhanced by Darwinian and Evolutionary Methods."

  URL Coming Soon!
- Kyle Kloster, Mathematics Undergraduate at Fordham,
  Bachelor's Thesis defended, May 7, 2010. "Factoring a semiprime n by estimating $\phi(n)$."
  http://www.gregorybard.com/papers/phi_version_may_7.pdf
- Michael Levin, Computer Science Master's Candidate at American University,
  Master's Thesis defended, April 22, 2010. "Darwinian Gradient Descent."
  http://www.gregorybard.com/papers/DarwinianGradientDescent.pdf

  (Note: I was the director of research and provided career guidance. The nominal supervisor was Prof. Michael Black, then of American University.)

Grants & Funding

See the full 19-page version of this CV, available at
http://www.gregorybard.com/papers/CV_long_form.pdf.

Service

See the full 19-page version of this CV, available at
http://www.gregorybard.com/papers/CV_long_form.pdf.

Mathematical Outreach Talks

See the full 19-page version of this CV, available at
http://www.gregorybard.com/papers/CV_long_form.pdf.

Honors & Awards

- UW Stout "Faculty Research Fellow" for 2017–2018.
- Best paper award: The 43rd International Conference on Applications of Mathematics in Engineering and Economics (AMEE'17), Sozopol, Bulgaria. July of 2017. For the paper "Uses and Misuses of Bayes' Rule and Bayesian Classifiers in Cybersecurity."
- UW Stout "Faculty Research Fellow" for 2015–2016.
- "Certificate of Achievement," Assoc. for Computing Machinery, for leading the American University 2005 Programming Team to an "Honorable Mention" in the Mid-Atlantic Conference (Nov. 2005).

- Winner, 2004–2005 "Spotlight on Graduate Research" Award, Department of Mathematics, University of Maryland, for my work on building hash-function families from pseudorandom function families. There were four total winners from among the Pure Math, Applied Math, Scientific Computation and Statistics programs. Included a cash award. (Nov. 2005).
- Ranked first place out of 21 Pure & Applied Mathematics students in the algebra written Qualifying Exams for the PhD program. (August 2005).
- Registered "Visiting Advanced Student," Oxford University, New College, 2004.
- NSA Eagle Award, December 1999, 2000, 2001, for charitable & community service acts.
- While at the NSA, seven letters of commendation and The Director's Star Award, August 1998, Note, two letters were signed by Michael Hayden, at that time a 3-star general and Director of the NSA.
- National Merit Scholarship Semi-Finalist, June 1995.

Invited Talks & Presentations (Selected)

1. The Mathematical Association of America MathFest Conference, Chicago, IL. July 28th, 2017. "Realistic Examples of Bayes's Rule from Cybersecurity."
2. The 7th International Conference on Algebraic Informatics (CAI'17) Cryptography and Coding Theory Track, Kalamata, Greece. June 28th, 2017. "Determining Whether a Given Block Cipher is a Permutation of Another Given Block Cipher (a Problem in Intellectual Property)."
3. The 43rd International Conference on Applications of Mathematics in Engineering and Economics (AMEE'17), Sozopol, Bulgaria. June 9th, 2017. "Bayesian Reasoning in Computer Science and Cybersecurity."
4. Mathematical Association of America (MAA) and American Mathematical Society (AMS) Joint Mathematics Meeting, Atlanta, GA. January 7th, 2017. "Four Problems from Computing to Enhance Student Enthusiasm in the Discrete Mathematics Classroom."
5. The Mathematical Association of America MathFest Conference, Columbus, OH. August 4th, 2016. "A New Application of the Markowitz Optimal Portfolio Theory and Its Efficient Frontier."
6. The 42nd International Conference on Applications of Mathematics in Engineering and Economics (AMEE'16), Sozopol, Bulgaria. June 12th, 2016. "A New Application of the Markowitz Optimal Portfolio Theory and its Efficient Frontier."
7. Mathematical Association of America (MAA) and American Mathematical Society (AMS) Joint Mathematics Meeting, Seattle, WA. January 8th, 2016. "The Two-Time Pad Problem: Plaintext Recovery for One-Time Pads Used Twice."
8. Wisconsin Project NEXT, Fall Meeting. Baraboo, Wisconsin. November 7th, 2015. "The Two-Time Pad Problem: Examined from the Teaching, Scholarship, and Service Perspectives."
9. The Fields Institute, Workshop on Linear Computer Algebra and Symbolic-Numeric Computation, Toronto, Ontario. October 28th, 2015. "Exploring the Extended Linearization Algorithm (or XL Algorithm) for Solving Polynomial Systems of Equations, with Remarks toward NP-Completeness."
10. Departmental Seminar. University of Wisconsin—Stout. October 2nd, 2015. "Introducing SageMathCloud."
11. The Applications of Computer Algebra Conference (ACA'15), Kalamata, Greece. July 20th, 2015. "Using SageMathCell and Sage Interacts to Reach Mathematically Weak Business Students."

12. The Applications of Computer Algebra Conference (ACA'15), Kalamata, Greece. July 23rd, 2015. "A Brief Introduction to the Extended Linearization Method (or XL Algorithm) for Solving Polynomial Systems of Equations."

13. Mathematical Association of America (MAA) and American Mathematical Society (AMS) Joint Mathematics Meeting, San Antonio, TX. January 12th, 2015. "Computing the Least Factorial that Multiplies a Rational Number into an Integer."

14. The Mathematical Association of America MathFest Conference, Portland, Oregon. August 7th, 2014. "Macroeconomics in Finite Math: Rediscovering and Recreating Leontief Analysis."

15. The Applications of Computer Algebra Conference (ACA'14), Fordham University, The Bronx, NY. July 11th, 2014. "Plaintext Recovery for One-Time Pads that are Used Twice."

16. Departmental Colloquium, University of Minnesota—Duluth. May 1st, 2014. "What is Algebraic Cryptanalysis?"

17. Departmental Colloquium, University of Wisconsin—River Falls. April 22nd, 2014. "Breaking Codes by Solving Polynomials: Algebraic Cryptanalysis."

18. Southeastern Regional Meeting of the American Mathematical Society (AMS) Louisville, Kentucky. October 5th, 2013. "Reducing the Number of Variables in a System of Equations during Algebraic Cryptanalysis, by Constructing a Forest."

19. Departmental Seminar. University of Wisconsin—Stout. September 13th, 2013. "A Demo of The Sage Single-Cell Server, SageMathCloud, and Sage Applets."

20. The 7th Annual Best Practices in STEM Conference, Baraboo, Wisconsin. August 21st, 2013. "Use of Interactive Webpages in Teaching."

21. Sage Education Days V, Seattle, Washington, June 21st, 2013. "Using Sage while Teaching Financial Math (and Calculus Too!)"

22. The 6th Annual Polytechnic Summit, Boston, Massachusetts. June 6th, 2013. "Rethinking Finite Math: Bridging Boundaries between Mathematics, Economics, Finance, and Business."

23. The Mathematical Association of America (MAA) Wisconsin Sectional Meeting, Marshfield, Wisconsin. April 5th, 2013. "Emerging Technologies in Mathematics Instruction."

24. Mathematical Association of America (MAA) and American Mathematical Society (AMS) Joint Mathematics Meeting, San Diego, California. January 12, 2013. "Pivoting Strategies in Sparse Gaussian Eliminations done mod p and their Impact upon Various Computer Algebra Tasks."

25. Wisconsin Project NEXT, Fall Meeting. Baraboo, Wisconsin. October 14, 2012. "Sage for the College Math Professor."

26. The 6th Annual Best Practices in Science, Math and Engineering Teaching Conference. Baraboo, Wisconsin. August 23, 2012. "Using Sage in Lower-Division Undergraduate Science Courses to Explore Functions, their Graphs, and Regressions."

27. SIAM Annual Meeting 2012. Minneapolis, Minnesota. July 9, 2012. "Breaking Codes by Solving Polynomials: Algebraic Cryptanalysis!"

28. Symbolic Computation Group Seminar. University of Waterloo, Ontario. June 13, 2012. "Breaking Codes by Solving Polynomials: Algebraic Cryptanalysis."

29–86. . . . removed to save space.
For the remainder, (a total of 86 including those listed here), plus my Mathematical Outreach talks (a total of 23 so far) please see the full 19-page version of this CV, available at
`http://www.gregorybard.com/papers/CV_long_form.pdf`.