

Robin Pemantle
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University of Pennsylvania
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CURRICULUM VITAE

Born: June 12, 1963, Walnut Creek, CA. U.S. citizen.

Education:

Ph.D. in probability theory under the supervision of Persi Diaconis (Harvard) from the Massachusetts Institute of Technology in August, 1988.

B.A. in pure mathematics from the University of California at Berkeley in June, 1984.

Research interests:

Probability theory

Combinatorics, chiefly Analytic Combinatorics in Several Variables

Professional experience:

2003 - present: Merriam Term Professor of Mathematics at the University of Pennsylvania. (Undergraduate Chair 2011-2014)

1999 - 2003: Professor of Mathematics at the Ohio State University.

1991 - 1999: Assistant / Associate (1994) / Full (1998) Professor of Mathematics at the University of Wisconsin-Madison.

1990 - 1991: Andreotti Assistant Professor of Mathematics and N.S.F. Postdoctoral Fellow at Oregon State University.

1989 - 1991: N.S.F. postdoctoral fellow at Berkeley (Statistics), Cornell (MSI postdoc) and Oregon State University.

1980 - 1984 Math specialist at Black Pine Circle K-8 School in Berkeley, CA.

1976 - 1977 Math specialist intern at Black Pine Circle K-8 School in Berkeley, CA

Honors and awards:

Simons Fellow, 2016

American Mathematical Society Fellow, elected 2012

Institute of Mathematical Statistics Fellow, elected 2001

Romnes Fellowship awarded 1997

Presidential Faculty Fellowship awarded 1993 (PFF=PYI=CAREER)

Sloan Foundation Fellowship awarded 1993.

Rollo Davidson Prize, awarded 1993.

Lilly Teaching Fellowship awarded 1993.

N.S.F. postdoctoral fellowship awarded 1988.

N.S.F. graduate fellowship awarded 1984.

Top five in the William Lowell Putnam Math Competition, 1981.

Doctoral dissertations supervised

Manuel Lladser (OSU, 2003), Andrew Bressler (Penn, 2009), Tong Zhu (Penn, 2010), Michael Lugo (Penn, 2010), Tim DeVries (Penn, 2011), Omar Abuzzahab (Penn, 2013), Jonathan Kariv (Penn, 2013), Shanshan Ding (Penn, 2014), Sneha Subramanian (Penn, 2014), Torin Greenwood (Penn, 2015), Julius Poh (Penn, 2015), Albert Chen (Penn, 2018), Josh Rosenberg (Penn, 2018) Kostis Karatapanis (Penn 2019) Marcus Michelen (Penn 2019) Eric Goodman (Penn 2022) Jiaming Xia (Penn 2022 co-advisor) Stephen Gillen (Penn 2022) Kaitian Jin (Penn 2024)

Current doctoral students: Collin Free

NSF Grants

DMS-1612674, DMS-1209117, DMS-0905937, DMS-0603821, DMS-0103635, DMS-9803249, DMS-9353149, DMS-9300191.

Recent organization

AIM Conference on ACSV, April, 2022

Recent Service

Simons Foundation Mathematics and Physical Sciences Division Scientific Advisory Board, April 2023-March 2027.

AMS Fellows Selection Committee, 2021-2025 (Chair in 2022)

Editor for the Transactions and Memoirs of the American Mathematical Society (2018–2024)

Editor for the Transactions of Mathematics and its Applications (2019–present)

SAIL committee (structured active in-class learning), 2013–present

Undergraduate Chair, Department of Mathematics, 2011–2014

Recent and scheduled invited talks:

Jeff Steif 65 birthday conference June, 2024

Jim Propp 2⁶ birthday conference, MIT June, 2024

SUNY Albany Math Colloquium, Albany March, 2024

Birnbaum Lecture (Univ. of Washington) November, 2023

70 Years of Percolation (Cambridge) July, 2023

Graduate and Undergraduate Level Teaching:

I have developed a year-long probability course at the Ph.D. level, for graduate students in pure and applied math, statistics and engineering. I have taught this at Penn in 2004-2021.

I have developed a parallel probability course at the Masters level focusing on probability modeling, taught three times since 2019.

I helped to develop the new non-STEM calculus sequence Math 1070–1080.

I developed a one-semester calculus course for business students, incorporating parts of Calc I, II and III and replacing the (somewhat absurd) Calc II requirement. This course, Math 110, is taught in an Active Learning format.

I have taught a number of graduate level topics courses including: Analytic Combinatorics in Several Variables, Random walks on graphs, a reading course in original papers in classical probability and statistical mechanics; I have supervised reading courses in point processes, random graphs, probabilistic number theory, and computational algebraic geometry.

Pre-service, Outreach, Active, K-12 and Experimental Teaching:

Active learning calculus at Penn 2013-2014

Penn Math 123: academically based community service, teaching geometry in an urban tenth grade classroom, 2004

OSU Math 151A (calculus problem-solving curriculum), 2000

OSU Math 105-106 (math for elementary school teachers, active learning) 2002

Wisconsin Math 130-132 (math for elementary school teachers, active learning) 1993–1998

Summer Institute in Mathematics knot theory, Berkeley, 1991. The SMI is a program for minority students at the college level who are interested in careers in mathematics.

MIT Experimental Study Group ordinary differential equations, partial Moore method course, 1987-88.

Taught math enrichment to children of ages 10-13 at Black Pine Circle School during the years 1980-1984

Completed teacher training course in middle school science teaching at Lawrence Hall of Science, 1980-1981.

Taught topics in algebra in eighth grade at Black Pine Circle School as a peer teaching intern during Academic Year 1976-77

R. PEMANTLE Publication List

Books

I Wish They Had Taught Me That! Topics in mathematics that are often omitted from coursework. Gould, J. and R. Pemantle. In progress, under contract for A.K. Peters.

There Is No One Way to Teach Math: Actionable ideas for grades 6–12. Picciotto, H. and R. Pemantle. Routledge, *to appear*, 2024. ISBN-13: 978-1-0327-5933-3.

Analytic Combinatorics in Several Variables, second edition. R. Pemantle, M. C. Wilson and S. Melczer. Cambridge Studies in Advanced Mathematics No. 212. Cambridge University Press, 2024. ISBN-13: 9781107031579.

Supersedes: *Analytic Combinatorics in Several Variables.* R. Pemantle and M. C. Wilson. Cambridge Studies in Advanced Mathematics No. 140. Cambridge University Press, 2013. ISBN-13: 9781107031579.

Mathemania: the BPC math contest problems. (2009) R. Pemantle, J. Wolinsky, D. Bach., M. Sloper and A Gulimovsky. Black Pine Curriculum Institute, 2009. ISBN-13: 978-0-979-2452-1-3.

Articles

- [1] Pemantle, R. (1988). Phase transition in reinforced random walk and RWRE on trees. *Ann. Probab.* **16** 1229 - 1241.
- [2] Pemantle, R. (1989). Randomization time for the overhand shuffle. *J. Theor. Prob.* **2** 37 - 49.
- [3] Pemantle, R. (1990). Nonconvergence to unstable points in urn models and stochastic approximations. *Ann. Probab.* **18** 698 - 712.
- [4] Pemantle, R. (1990). A time-dependent version of Polya's urn. *Jour. Theor. Prob.* **3** 627 - 637.
- [5] Fill, J. and Pemantle, R. (1993). Oriented percolation, first-passage percolation and covering times for Richardson's model on the n -cube. *Ann. Appl. Prob.* **3** 593 - 629.
- [6] Pemantle, R. (1990). Vertex-reinforced random walk. *Prob. Theor. and Rel. Fields* **92** 117 - 136.
- [7] Pemantle, R. (1991). When are touchpoints limits for generalized Polya urns? *Proc. AMS* **113** 235 - 243.
- [8] Pemantle, R. and Peres, Y. (1995). Critical RWRE on trees and tree-indexed random walks. *Ann. Probab.* **23** 105 - 140.
- [9] Pemantle, R. (1991). Choosing a spanning tree for the integer lattice uniformly. *Ann. Probab.* **19** 1559 - 1574.

- [10] Pemantle, R. and Lyons, R. (1992). Random walk in a random environment and first-passage percolation on trees. *Ann. Probab.* **20** 125 - 136.
- [11] Pemantle, R., Propp, J. and Ullman, D. (1992). On tensor powers of integer programs. *SIAM J. Disc. Math.* **5** 127 - 143.
- [12] Pemantle, R. (1992). Automorphism-invariant measures on trees. *Ann. Probab.* **20** 1549 - 1566.
- [13] Pemantle, R. (1992). The contact process on trees. *Ann. Probab.* **20** 2089 - 2116.
- [14] Pemantle, R. and Penrose, M. (1992). On path integrals for the high-dimensional Brownian bridge. *J. Comput. Appl. Math.* **44** 381 - 390.
- [15] Burton, R. and Pemantle, R. (1993). Local characteristics, entropy and limit theorems for uniform spanning trees and domino tilings via transfer-impedances. *Ann. Prob.* **21** 1329 - 1371.
- [16] Pemantle, R. (1993). Critical RWRE on trees of exponential growth. *Proc. Sem. Stoch. Pro. 1992, Burdzy and Bass, editors*, 221 - 240.
- [17] Pemantle, R. and Peres, Y. (1994). Planar first-passage times are not tight. In: *Probability and Phase Transition*, G. Grimmett Editor, 261 - 264. Kluwer: Boston.
- [18] Pemantle, R. and Peres, Y. (1994). Domination between trees and application to an explosion problem. *Ann. Probab.* **22** 180 - 194.
- [19] Pemantle, R. (1994). A shuffle that mixes sets of any fixed size much faster than it mixes the whole deck. *Rand. Struct. Alg.* **9** 609 - 625.
- [20] Pemantle, R. (1994). Uniform random spanning trees. In: *Topics in contemporary probability and its applications*, J. L. Snell, editor, pages 1 - 54. CRC Press: Boca Raton.
- [21] Pemantle, R. (1995). Tree-indexed processes. *Stat. Sci.* **5** 200 - 213.
- [22] Pemantle, R. and Peres, Y. (1995). Galton-Watson trees with the same mean have the same polar sets. *Ann. Probab.* **23** 1102 - 1124.
- [23] Benjamini, I., Pemantle, R. and Peres, Y. (1995). Martin capacity for Markov chains. *Ann. Probab.* **23** 1332 - 1346.
- [24] Lyons, R., Pemantle, R. and Peres, Y. (1995). A conceptual proof of the Kesten-Stigum theorem. *Ann. Probab.* **23** 1125 - 1138.
- [25] Diaconis, P., Holmes, S., Janson, S., Lalley, S. and Pemantle, R. (1995). Metrics on compositions and coincidences among renewal processes. In: *Random Discrete Structures*, 81 - 101, *IMA Vol. Math. Appl.* **76**. Springer: New York.

- [26] Lyons, R., Pemantle, R. and Peres, Y. (1995). Ergodic Theory on Galton Watson trees: Speed of random walk and dimension of harmonic measure on Galton-Watson trees. *Ergodic Theory and Dynamical Systems* **15** 593 - 619.
- [27] Pemantle, R. (1996). The probability that Brownian motion almost covers a line. *Ann. IHP, Prob. and Stat.* **33** 147 - 165.
- [28] Pemantle, R. (1996). Maximum variation of total risk. *Stat. Prob. Letters* **28** pages 285 - 289.
- [29] Benjamini, I., Pemantle, R. and Peres, Y. (1996). Random walks in varying dimensions. *J. Theor. Prob.* **9** 231 - 244.
- [30] Lyons, R., Pemantle, R. and Peres, Y. (1996). Random walks on the Lamplighter group. *Ann. Probab.* **24** 1993 - 2006.
- [31] Pemantle, R. and Peres, Y. (1996). On which graphs are all random walks in random environments transient? In: *Random Discrete Structures*, 207 - 211, *IMA Vol. Math. Appl.* **76**. Springer: New York.
- [32] Pemantle, R., Peres, Y. and Shapiro, J. (1996). The trace of spatial Brownian motion is capacity-equivalent to the unit square. *P.T.R.F.* **106** 379 - 399.
- [33] Lyons, R., Pemantle, R. and Peres, Y. (1996). Biased random walks on Galton-Watson trees. *P.T.R.F.* **106** 249 - 264.
- [34] Barlow, M., Pemantle, R. and Perkins, E. (1997). Diffusion limited aggregation on a homogeneous tree. *Prob. Th. Rel. Fields* **107** 1 - 60.
- [35] Pemantle, R. (1997). Sharpness of second moment criteria for branching and tree-indexed processes. In: *Classical and modern branching processes*, 257 - 262, *IMA Vol. Math. Appl.* **84**. Springer: New York.
- [36] Lyons, R., Pemantle, R. and Peres, Y. (1997). Unsolved problems concerning random walks on trees. In: *Classical and modern branching processes*, 223 - 237, *IMA Vol. Math. Appl.* **84**. Springer: New York.
- [37] Lyons, R., Pemantle, R. and Peres, Y. (1997). A conceptual proof of the Kesten-Stigum Theorem for multi-type branching processes. In: *Classical and modern branching processes*, 181 - 186, *IMA Vol. Math. Appl.* **84**. Springer: New York.
- [38] Bishop, C., Jones, P., Pemantle, R. and Peres, Y. (1997). Brownian frontier has dimension greater than 1. *J. Func. Anal.* **43** 309 - 336.
- [39] Hwang, J. and Pemantle, R. (1997). Evaluators of estimates of statistical significance under a class of proper loss functions. *Statistics and Decisions* **15** 103 - 128.

- [40] Chayes, L., Pemantle, R. and Peres, Y. (1997). No directed fractal percolation in zero area. *J. Stat. Phys.* **88** 1353 - 1362.
- [41] Pemantle, R. and Volkov, S. (1998). Markov chains in a field of traps. *J. Theor. Prob.* **11** 561 - 569.
- [42] Häggström, O. and Pemantle, R. (1998). First passage percolation and a model for competing spatial growth. *J. Appl. Prob.* **35** 683 - 692.
- [43] Adelman, O., Burdzy, K. and Pemantle, R. (1998). Sets avoided by Brownian motion. *Ann. Prob.* **26** 429 - 464.
- [44] Benjamini, I., Pemantle, R. and Peres, Y. (1998). Unpredictable paths and percolation. *Ann. Probab.* **26** 1198 - 1211.
- [45] Lyons, R., Pemantle, R. and Peres, Y. (1999). Resistance bounds for first-passage percolation and maximum flow. *J. Comb. Theor. A* **86** 158 - 168.
- [46] Häggström, O. and Pemantle, R. (1999). On near-critical and dynamical percolation in the tree case. *Rand. Struc. Alg.* **15** 311 - 318.
- [47] Pemantle, R. and Volkov, S. (1999). Vertex-reinforced random walk on Z has finite range. *Ann. Probab.* **27** 1368 - 1388.
- [48] Pemantle, R. and Steif, J. (1999). Robust phase transitions for Heisenberg and other models on general trees. *Ann. Probab.* **27** 876 - 912.
- [49] Pemantle, R. and Rosenthal, J. (1999). Moment conditions for a sequence with negative drift to be uniformly bounded in L^r . *Stoch. Pro. Appl.* **82**, 143 - 155.
- [50] Khoshnevisan, D. and Pemantle, R. (2000). Sojourn times of Brownian sheet. *Period. Math. Hungar.* **41**, 187–194
- [51] Skyrms, B. and Pemantle, R. (2000). A dynamic model of social network formation. *Proc. NAS* **97** 9340–9346. Reprinted in: *Adaptive Networks 231–251*, T. Gross and M. Sayama editors. Springer: New York. ISBN: 978-3-642-01283-9.
- [52] Pemantle, R. (2000). Toward a theory of negative dependence. *J. Stat. Phys.* **41** 1371–1390.
- [53] Pemantle, R. and Peres, Y. (2000). Non-amenable products are not treeable. *Israel J. Math.* **118** 147–155.
- [54] Pemantle, R. (2000). Generating functions with high order poles are nearly polynomial. In: *Mathematics and Computer Science: Algorithms, trees, combinatorics and probabilities.*, 305–321. Birkhäuser: Basel.
- [55] Pemantle, R., Peres, Y., Pitman, J. and Yor, M. (2000). Where did the Brownian particle go? *Elec. J. Prob* **6**, paper 10, 22 pages.

- [56] Häggström, O. and Pemantle, R. (2000). Absence of mutual unbounded growth for almost all parameter values in the two-type Richardson model. *Stoch. Pro. Appl.* **90**, 207–222.
- [57] Pemantle, R. and Stacey, A. (2001). The branching random walk and contact process on Galton–Watson and non–homogeneous trees. *Ann. Probab.* **29**, 1563–1590.
- [58] Levin, D., Pemantle, R. and Peres, Y. (2001). A phase transition in random coin tossing. *Ann. Probab.* **29**, 1637–1669.
- [59] Pemantle, R. and Wilson, M. (2002). Asymptotics of multivariate sequences, part I: smooth points of the singular variety. *JCT A* **97**, 129–161.
- [60] Cohn, H., Pemantle, R., Propp, J. (2002). Generating a random sink-free orientation in quadratic time. *Elec. J. Comb.* **9**(1), paper R10.
- [61] Limic, V. and Pemantle, R. (2003). More rigorous results on the Kauffman-Levin model of evolution. *Ann. Probab.* **32**, 2149–2178.
- [62] Pemantle, R. and Skyrms, B. (2003). Network formation by reinforcement learning: the long and the medium run. *Math. Soc. Sci.* **48**, 315–327.
- [63] Kakade, S., Kearns, M., Ortiz, L., Pemantle, R. and Suri, S. (2004). The economics of social networks. In: *Proceedings of NIPS, 2004*.
- [64] Pemantle, R. and Wilson, M. (2004). Asymptotics of multivariate sequences, part II: Multiple points of the singular variety. *Comb. Prob. Comput.* **13**, 735–761.
- [65] Pemantle, R. and Skyrms, B. (2004). Time to absorption in discounted reinforcement models. *Stoch. Proc. Appl.* **109**, 1–12.
- [66] Skyrms, B. and Pemantle, R. (2004). Learning to network. In: *The Place of Probability in Science*, ed. Ellery Eells and James Fetzer. Open Court.
- [67] Corteel, S., Louchard, G. and Pemantle, R. (2006). Common intervals in permutations. *Disc. Math. Theor. Comp. Sci.* **8** 189–214. Extended abstract appeared in *Mathematics and Computer Science III*, (M. Drmota, P. Flajolet, D. Gardy and B. Gittenberger, Editors) pages 3–14, (2004).
- [68] Bender, E., Lawler, G., Pemantle, R. and Wilf, H. (2004). Irreducible compositions and the first return to the origin of a random walk. *Seminaire Loth.* **50** paper B50h, 12 pages.
- [69] Hitczenko, P. and Pemantle, R. (2004). Central limit theorem for the size of the range of a renewal process. *Stat. Prob. Let.* **72**, 249–264.
- [70] Pemantle, R. (2005). Poor performance of random random number generators. *J. Algorithms* **54**, 72–81.

- [71] Pemantle, R. (2005). A probabilistic model for the degree of the cancellation polynomial in Gosper’s Algorithm. *J. Algorithms* **54**, 58–71.
- [72] Pemantle, R. and Ward, M. (2006). Exploring the average values of Boolean functions via asymptotics and experimentation. In: *The Proceedings of the Third Workshop on Analytic Algorithmic and Combinatorics (ANALCO’06)* 253–262.
- [73] Bressler, A. and Pemantle, R. (2007). Quantum random walk in one dimension via generating functions. In: *DMTCS Proceedings, 2007 Conference on Analysis of Algorithms. Extended Abstract, 11 pages*.
- [74] Balogh, J. and Pemantle, R. (2007). The Klee-Minty random edge chain moves with linear speed. *Rand. Struct. Alg.* **30**, 464–483.
- [75] Pemantle, R. and Peres, Y. (2007). When does a set intersect the set of Brownian double points? *Ann. Probab.* **35**, 2044–2062.
- [76] Pemantle, R. and Schneider, C. (2007). When is $0.999\dots$ equal to 1? *Amer. Math. Monthly* **114**, 344–350.
- [77] Pemantle, R. (2007). A survey of random processes with reinforcement. *Probability Surveys* **4** 1–79.
- [78] Pemantle, R. and Wilson, M. (2008). Twenty combinatorial examples of asymptotics derived from multivariate generating functions. *SIAM Review*, vol. 50, 199–272.
- [79] Croot, E., Granville, A., Pemantle, R. and Tetali, P. (2008). Running time predictions for factoring algorithms. In: *Algorithmic Number Theory (Lecture Notes in Computer Science vol. 5011)*. Springer: Berlin.
- [80] Pemantle, R. (2009). Search cost for a nearly optimal path in a binary tree. *Ann. Appl. Prob.* **19**, 1273–1291.
- [81] Argiento, R., Pemantle, R., Skyrms, B. and Volkov, S. (2009). Learning to signal: analysis of a micro-level reinforcement model. *Stoch. Proc. Appl.* **119**, 373–390.
- [82] Holroyd, A. Pemantle, R., Peres, Y., and Schramm, O. (2009). Poisson matching. *Ann. I.H.P. Prob. Stat.* **45**, 266–287.
- [83] Pemantle, R. and Wilf, H. (2009). Counting nondecreasing integer sequences lying below a barrier. *Elec. J. Comb.* **16**, research paper # 60, 7 pages.
- [84] Pemantle, R. and Wilson, M. (2010). Asymptotic expansions of oscillatory integrals with complex phase. *To appear in Proceedings of the AMS Special session on Algorithmic Probability and Combinatorics (refereed)*, Lladser, Maier, Mishna and Rechnitzer editors, 18 pages.

- [85] Bressler, A., Greenwood, T., Pemantle, R. and Petkovsek, M. (2010). Quantum random walk on the integer lattice: examples and phenomena. *To appear in Proceedings of the AMS Special session on Algorithmic Probability and Combinatorics (refereed)*, Lladser, Maier, Mishna and Rechnitzer editors, 17 pages.
- [86] Pemantle, R. (2010). Analytic combinatorics in several variables: an overview. *To appear in Contemporary Mathematics*, **520**, 195–220. AMS Special session on Algorithmic Probability and Combinatorics (refereed), Lladser, Maier, Mishna and Rechnitzer editors, 24 pages.
- [87] Pemantle, R. and Peres, Y. (2010). The critical Ising model on trees, concave recursions and nonlinear capacity. *Ann. Probab.* **38**, 184–206.
- [88] Baryshnikov, Y., Brady, W., Bressler, A. and Pemantle, R. (2010). Two-dimensional quantum random walk. *J. Stat. Phys.* **142** 78–107.
- [89] Baryshnikov, Y. and Pemantle, R. (2011). Asymptotics of multivariate sequences, part III: quadratic points. *Adv. Math.* **228** 3127–3206.
- [90] DeVries, T., van der Hoeven, J. and Pemantle, R. (2011) Automatic computation of asymptotics of coefficients for smooth bivariate rational generating functions. *Online J. Anal. Comb.* **6**, 24 pages.
- [91] Croot, E., Granville, A., Pemantle, R. and Tetali, P. (2012). Sharp transitions in making squares. *Ann. Math.* **175**, 1–45.
- [92] Pemantle, R. (2012) Hyperbolicity and stable polynomials in combinatorics and probability. *In: Current Developments in Mathematics*, pages 57–124, Jerison, Mrowka, Mazur, Schmid, Stanley and Yau, editors. International Press: Somerville, MA.
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- [94] Pemantle, R. and Peres, Y. (2013). Concentration inequalities of Lipschitz functionals of determinantal and other strong Rayleigh measures. *Comb., Prob. Comput.* **23**, 140–160.
- [95] Kenyon, R. and Pemantle, R. (2014). Principal Minors and rhombus tilings. *J. Phys. A*, **47**, 474010.
- [96] Pak, I. and Pemantle, R. (2014). On the longest k -alternating subsequence. *Elec. J. Comb.* **22**, Issue 1, paper 1.48.
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- [99] Satopää, V., Jensen, S., Pemantle, R. and Ungar, L. (2017). Partial Information Framework: Aggregating estimates from diverse information sources. *Elec. J. Stat.* **vol. 11** 3781–3814.
- [100] Alon, N., Mossel, E. and Pemantle, R. (2019). Corruption detection and expansion. *Theory of Computing, to appear, 20 pages*.
- [101] Ernst, P., Satopää, V., Pemantle, R. and Ungar, L. (2016). Bayesian aggregation of two forecasts in the partial information framework. *Stat. Prob. Let.* **119**, 170–180.
- [102] Kenyon, R. and Pemantle, R. (2016). Double-dimers, the Ising model and the hexahedron recurrence. *J. Comb. Theory, ser. A* **137** 27–63. Extended abstract appeared in FPSAC 2013.
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- [104] Satopää, V., Pemantle, R. and Ungar, L. (2016). Modeling probability forecasts via information diversity. *J. Amer. Stat. Assoc.* **111**, 1623–1633.
- [105] Subramanian, S. and Pemantle, R. (2017). Repeated differentiation evens the spacing of zeros when the zeros are initially translation-invariant and Poisson. *Trans. AMS* **369**, 8743–8764.
- [106] Lazar, E. and Pemantle, R. (2017). Coarsening in One Dimension: Invariant and asymptotic states. *Israel J. Math* **221**, 59–84.
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- [110] Michelen, M., Pemantle, R. and Rosenberg, J. (2019). Invasion percolation on Galton-Watson trees. *Elec. J. Prob.* **24** paper no. 31, 1–35.
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