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## Bibliography

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- [1] E. AÏDÉKON, B. JAFFUEL. Survival of branching random walks with absorption. *Stochastic Processes and Their Applications*, vol. 121, pp. 1901–1937 (2011).
- [2] D. ALDOUS, P. DIACONIS. Shuffling cards and stopping times. *Amer. Math. Monthly*, vol. 93, pp. 333–348 (1986).
- [3] H.C. ANDERSEN, P. DIACONIS. Hit and run as a unifying device. *Journal de la société Frangaise de statistique*, vol. 148, no.4, pp. 5–28 (2007)
- [4] C. ANDRIEU, A. DOUCET AND R. HOLENSTEIN. Particle Markov chain Monte Carlo methods. *J. R. Statist. Soc. B*, 72, Part 3, pp. 269–342 (2010).
- [5] S. ASMUSSEN, P.W. GLYNN. *Stochastic Simulation. Algorithms and Analysis*. Springer Series: Stochastic Modelling and Applied Probability, vol. 57 (2007).
- [6] S. ASMUSSEN, H. HERING. *Branching Processes*. Birkhäuser, Boston (1983).
- [7] K. B. ATHREYA, P.E. NEY. *Branching Processes*, Springer, NewYork (1972).
- [8] L. BACHELIER. The theory of speculation. *Annales scientifiques de l'École Normale Supérieure*, vol. 3, no. 17, pp. 21–86 (1900).
- [9] D. BAKRY, M. EMERY. Diffusions hypercontractives, Séminaire de probabilités XIX. Strasbourg University, Springer (1983).
- [10] A. R. BANSAL, V. P. DIMRI AND K. K. BABU. Epidemic type aftershock sequence (ETAS) modeling of northeastern Himalayan seismicity. *Journal of Seismology*, vol. 17, no. 2, pp. 255–264 (2013).
- [11] M. BARNSLEY, *Fractals Everywhere*. San Diego, Academic Press (1988).
- [12] J. BARRAL, R. RHODES AND V. VARGAS. Limiting laws of supercritical branching random walks. *Comptes Rendus de l'Académie des Sciences - Series I - Mathematics*, vol. 350, no 9-10, pp. 535–538 (2012).
- [13] D. BAYER, P. DIACONIS. Trailing the dovetail shuffle to its lair. *Annals of Applied Probability*, vol. 2, no. 2, pp. 294–313 (1992).
- [14] D. BEEMAN. Some multistep methods for use in molecular dynamics calculations. *Journal of Computational Physics*, vol. 20, no. 2, pp. 130–139 (1976).
- [15] C. J. P. BÉLISLE, H. E. ROMEIJN, AND R. L. SMITH. Hit-and-run algorithms for generating multivariate distributions. *Math. Oper. Res.*, vol. 18, no. 2, pp. 255–266 (1993).
- [16] E. BEN-NAIM, P.L. KRAPIVSKY. Cluster approximation for the contact process. *J. Phys. A: Math. Gen.*, vol. 27 pp. 481–487 (1994).

- [17] M. BENAÏM, S. LE BORGNE, F. MALRIEU AND P.A. ZITT Quantitative ergodicity for some switched dynamical systems. *Electronic Communications in Probability*, vol. 17, no. 56, pp. 1–14 (2012).
- [18] J. BERESTYCKI, N. BERESTYCKI, AND J. SCHWEINSBERG. Critical branching Brownian motion with absorption: survival probability. *ArXiv:1212.3821v2 [math.PR]* (2012).
- [19] J. M. BERNARDO, A. F. M. SMITH. *Bayesian Theory*. Wiley, Chichester (1994).
- [20] J. BERTOIN. *Random fragmentation and coagulation processes*. Cambridge Studies in Advanced Mathematics, Cambridge University Press (2006).
- [21] D. P. BERTSEKAS, S. E. SHREVE. *Stochastic Optimal Control: The Discrete-Time Case*. Academic Press (1978).
- [22] J. BESAG, P.J. DIGGLE. Simple Monte Carlo tests for spatial pattern. *Journal of the Royal Statistical Society*, vol. 26, No. 3, pp. 327–333 (1977).
- [23] J. D. BIGGINS. Uniform convergence of martingales in the branching random walk. *Ann. Probab.* vol. 20, pp. 137–151 (1992).
- [24] Z. W. BIRNBAUM. An inequality for Mill’s ratio. *The Annals of Mathematical Statistics*, vol. 13, pp. 245–246 (1942).
- [25] F. BLACK, M. SCHOLES. The pricing of options and corporate liabilities. *Journal of Political Economy*, vol. 81, no. 3, pp. 637–654 (1973).
- [26] S. BOBZIEN. *Determinism and Freedom in Stoic Philosophy*. Oxford University Press (2001).
- [27] C. G. E. BOENDER, R. J. CARON, J. F. McDONALD, A. H. G. RINNOY KAN, H. E. ROMEIJN, R. L. SMITH, J. TELGEN AND A. C. F. VORST. Shake-and-bake algorithms for generating uniform points on the boundary of bounded polyhedra. *Operations Research*, vol. 39, no.6. pp. 945–954 (1991).
- [28] M. BORN, J.R. OPPENHEIMER. On the quantum theory of molecules. *Annalen der Physik* (in German), vol. 389, no. 20, pp. 457–484 (1927).
- [29] L. von BORTKIEWICZ. *Das Gesetz der kleinen Zahlen*, Leipzig: B.G. Teubner (1898).
- [30] A. BOUCHARD-CÔTÉ, S.J. VOLLMER AND A. DOUCET. *The bouncy particle sampler: a non-reversible rejection-free Markov chain Monte Carlo method*. *ArXiv:1510.02451* (2015).
- [31] N. BOU-RABEE, M. HAIRER. Nonasymptotic mixing of the MALA algorithm. *IMA Journal of Numerical Analysis* (2012).
- [32] C. G. BOWSHER. Modelling security market events in continuous time: intensity based, multivariate point process models. *Journal of Econometrics*, vol. 141, pp. 876–912 (2007).
- [33] M. D. BRAMSON. Maximal displacement of branching Brownian motion. *Comm. Pure Appl. Math.*, vol 31, pp. 531–581 (1978).
- [34] J. K. BROOKS. Representations of weak and strong integrals in Banach spaces. *Proc. Nat. Acad. Sci. U.S.A.*, vol. 63, pp. 266–270 (1969).

- [35] S. BROWNE, K. SIGMAN. Work-modulated queues with applications to storage processes. *Journal of Applied Probability*, vol. 29, no. 3, pp. 699–712 (1992).
- [36] B. E. BRUNET, B. DERRIDA, A. H. MULLER, AND S. MUNIER. Effect of selection on ancestry: an exactly soluble case and its phenomenological generalization. *Phys. Review E*, vol. 76, 041104 (2007).
- [37] M. CAFFAREL, R. ASSARAF. A pedagogical introduction to quantum Monte Carlo. In *Mathematical Models and Methods for Ab Initio Quantum Chemistry* in Lecture Notes in Chemistry, eds. M. Defranceschi and C. Le Bris, Springer p. 45 (2000).
- [38] G. CANTOR. Über unendliche, lineare Punktmannigfaltigkeiten, *Mathematische Annalen*, vol. 21, pp. 545–591 (1883).
- [39] O. CAPPÉ, E. MOULINES AND T. RYDÈN. *Inference in Hidden Markov Models*, Springer (2005).
- [40] R. CARMONA, J.-P. FOUCHE AND L.-H. SUN. Mean Field Games and Systemic Risk, *Communications in Mathematical Sciences*, vol. 13, no. 4, 911–933 (2015).
- [41] F. CARON, P. DEL MORAL, A. DOUCET AND M. PACE. On the conditional distributions of spatial point processes *Adv. in Appl. Probab.*, vol. 43, no. 2, pp. 301–307 (2011).
- [42] B. CASCALES, M. RAJA. Measurable selectors for the metric projection. *Mathematische Nachrichten*, vol. 254–255, 1, pp. 27–34 (2003).
- [43] C. CASSANDRAS, J. LYGEROS (Editors). *Stochastic Hybrid Systems*, CRC Press (2007).
- [44] D. G. CATCHSIDE, D. E. LEA AND J. M. THODAY. Types of chromosomal structural change induced by the irradiation of Tradescantia microspores. *Journal of Genetics*, vol. 47, pp. 113–136 (1945).
- [45] N. CHAMPAGNAT. A microscopic interpretation for adaptive dynamics trait substitution sequence models. *Stochastic Process. Appl.*, vol. 116, no. 8, pp. 1127–1160 (2006).
- [46] N. CHAMPAGNAT, R. FERRIÈRE AND S. MÉLÉARD. From individual stochastic processes to macroscopic models in adaptive evolution. *Stoch. Models*, vol. 24, no. 1, pp. 2–44 (2008).
- [47] N. CHAMPAGNAT, S. MÉLÉARD. Polymorphic evolution sequence and evolutionary branching. *Probab. Theory Related Fields*, vol. 151, no. 1–2, pp. 45–94 (2011).
- [48] R. CHELLI, S. MARSILI, A. BARDUCI AND P. PROCACCI. Generalization of the Jarzynski and Crooks nonequilibrium work theorems in molecular dynamics simulations *Phys. Rev. E*, vol. 75, no. 5, 050101(R) (2007).
- [49] L. Y. CHEN. On the Crooks fluctuation theorem and the Jarzynski equality. *J. Chem. Phys.*, vol. 129, no. 9, 091101 (2008).
- [50] M.H. CHEN, B. SCHMEISER. Performance of the Gibbs, hit-and-run, and Metropolis samplers. *Journal of Computational and Graphical Statistics*, vol. 2, no. 3, pp. 251–272 (1993).
- [51] P. CLIFFORD, A. SUDBURY. A model for spatial conflict. *Biometrika*, vol. 60, no. 3, pp. 581–588 (1973).

- [52] R. D. CLARKE. An application of the Poisson distribution. *Journal of the Institute of Actuaries*, vol. 72, p. 481 (1946).
- [53] G. COLATA. In shuffling cards, 7 is winning number. Section C; Page 1, January 9, *New York Times* (1990).
- [54] F. COMETS, T. SHIGA AND N. YOSHIDA. Probabilistic analysis of directed polymers in a random environment: a review. *Adv. Stud. in Pure Math.*, vol. 39. Mathematical Society of Japan (2004).
- [55] F. COMETS, S. POPOV, G. M. SCHÜTZ AND M. VACHKOVSKAIA. Billiards in a general domain with random reflections. *Archive for Rational Mechanics and Analysis*, vol. 191, no. 3, pp. 497–537 (2008).
- [56] G. COMO, F. FAGNANI. Scaling limits for continuous opinion dynamics systems. *The Annals of Applied Probability*, vol. 21, no. 4, pp. 1537–156 (2011).
- [57] B. COOKE, J.C. MATTINGLY, S.A. MCKINLEY AND S.C. SCHMIDLER. Geometric ergodicity of the two-dimensional Hamiltonian systems with a Lennard-Jones-like repulsive potential. [eprint arXiv:1104.3842](#) (2011).
- [58] D. R. COX. Some statistical methods connected with series of events. *Journal of the Royal Statistical Society*, vol. 17, no. 2, pp. 129–164 (1955).
- [59] H. CRAMÉR. *Mathematical methods of statistics*. New Jersey: Princeton University Press. Princeton (1946). Reprinted (1974).
- [60] CRISAN D., DEL MORAL P. AND LYONS T. Discrete filtering using branching and interacting particle systems. *Markov Processes and Related Fields*, vol. 5, no. 3, pp. 293–318 (1999).
- [61] CRISAN D., DEL MORAL P. AND LYONS T. Interacting particle systems approximations of the Kushner Stratonovitch equation. *Advances in Applied Probability*, vol.31, no.3, pp. 819–838 (1999).
- [62] A. CZUMAJ, P. KANAREK, M. KUTYLOWSKI AND K. LORYS. Delayed path coupling and generating random permutations via distributed stochastic processes. *Proceedings of the Tenth Annual ACM-SIAM Symposium on Discrete Algorithms*, pp. 271-280. Society for Industrial and Applied Mathematics, Philadelphia (1999).
- [63] M.H.A. DAVIS. Piecewise-deterministic Markov processes: a general class of non-diffusion stochastic models. *Journal of the Royal Statistical Society. Series B*, vol. 46, no. 3, pp. 353–388 (1984).
- [64] P. DEL MORAL. Nonlinear filtering: interacting particle solution. *Markov Processes and Related Fields*, vol. 2, no. 4, pp. 555–580 (1996).
- [65] P. DEL MORAL. Measure valued processes and interacting particle systems. Application to nonlinear filtering problems. *Annals of Applied Probability*, vol. 8, no. 2, pp. 438–495 (1998).
- [66] P. DEL MORAL. *Feynman-Kac Formulae. Genealogical and Interacting Particle Systems*, Springer, (2004).
- [67] P. DEL MORAL. *Mean Field Simulation for Monte Carlo Integration*. Chapman & Hall/CRC Press. Monographs on Statistics and Applied Probability (2013).

- [68] P. DEL MORAL, A. DOUCET AND A. JASRA. *Sequential Monte Carlo samplers.* *J. R. Statist. Soc. B*, vol. 68, pp. 411–436 (2006).
- [69] P. DEL MORAL AND A. DOUCET. Particle motions in absorbing medium with hard and soft obstacles. *Stochastic Anal. Appl.*, vol. 22, pp. 1175–1207 (2004).
- [70] P. DEL MORAL, A. DOUCET. Interacting Markov chain Monte Carlo methods for solving nonlinear measure-valued equations. *Annals of Applied Probability*, vol. 20, no. 2, pp. 593–639 (2010).
- [71] P. DEL MORAL, A. DOUCET AND S. S. SINGH. A backward particle interpretation of Feynman-Kac formulae. *M2AN ESAIM*, vol 44, no. 5, pp. 947–976 (Sept. 2010).
- [72] P. DEL MORAL, A. DOUCET AND S. S. SINGH. Forward smoothing using sequential Monte Carlo. Technical Report CUED/F-INFENG/TR 638. Cambridge University Engineering Department (2009).
- [73] P. DEL MORAL, A. DOUCET AND S. S. SINGH. Computing the filter derivative using Sequential Monte Carlo. Technical Report. Cambridge University Engineering Department (2011).
- [74] P. DEL MORAL, A. GUIONNET. On the stability of measure valued processes with applications to filtering. *C. R. Acad. Sci. Paris Sér. I Math.*, vol. 329, pp. 429–434 (1999).
- [75] P. DEL MORAL, A. GUIONNET. On the stability of interacting processes with applications to filtering and genetic algorithms. *Ann. Inst. Henri Poincaré*, vol. 37, no. 2, pp. 155–194 (2001).
- [76] P. DEL MORAL, N. HADJICONSTANTINOU. An introduction to probabilistic methods, with applications. *M2AN ESAIM*, vol. 44, no. 5, pp. 805–830 (2010).
- [77] P. DEL MORAL, L. MICLO Self interacting Markov chains. *Stochastic Analysis and Applications*, vol. 24, no. 3, pp. 615–660 (2006).
- [78] P. DEL MORAL, L. MICLO On convergence of chains with time empirical self-interactions. *Proc. Royal Soc. Lond. A.*, vol. 460, pp. 325–346 (2003).
- [79] P. DEL MORAL, L. MICLO *Asymptotic Results for Genetic Algorithms with Applications to Nonlinear Estimation*. In KALLEL, L. ET AL. (EDS). *Theoretical Aspects of Evolutionary Computing*. Springer Berlin Heidelberg. Natural Computing Series, pp. 439–493 (2001).
- [80] P. DEL MORAL, L. MICLO, F. PATRAS AND S. RUBENTHALER The convergence to equilibrium of neutral genetic models. *Stochastic Analysis and Applications*, vol. 28, no. 1, pp. 123–143 (2009).
- [81] P. DEL MORAL, L. MICLO. *Branching and Interacting Particle Systems Approximations of Feynman-Kac Formulae with Applications to Non-Linear Filtering*. Seminaire de Probabilits XXXIV, Lecture Notes in Mathematics, Springer, vol. 1729, pp. 1–145 (2000).
- [82] P. DEL MORAL, L. MICLO. Particle approximations of Lyapunov exponents connected to Schrödinger operators and Feynman-Kac semigroups. *ESAIM: Probability and Statistics*, no. 7, pp. 171–208 (2003).

- [83] P. DEL MORAL AND J. TUGAUT. On the stability and the uniform propagation of chaos properties of Ensemble Kalman-Bucy filters Arxiv:1605.09329 (2016).
- [84] P. DEL MORAL, A. KURTZMANN AND J. TUGAUT. On the Stability and the Exponential Concentration of Extended Kalman-Bucy filters. ArXiv:1606.08251 (2016).
- [85] P. DEL MORAL, A. KURTZMANN AND J. TUGAUT. On the stability and the uniform propagation of chaos of Extended Ensemble Kalman-Bucy filters. ArXiv:1606.08256 (2016).
- [86] P. DEL MORAL, CH. VERGÉ. *Stochastic models and methods. An introduction with applications (in French)*. Springer Series on Maths and Applications (SMAI), vol. 75 (2014).
- [87] A. DE MASI, A. GALVES,E. LÖCHERBACH AND E. PRESUTTI. Hydrodynamic limit for interacting neurons. ArXiv preprint arXiv:1401.4264 (2014).
- [88] B. DERRIDA, D. SIMON. The survival probability of a branching random walk in the presence of an absorbing wall. *Europhys. Lett. EPL*, vol. 78, Art. 60006 (2007).
- [89] B. DERRIDA, D. SIMON. Quasi-stationary regime of a branching random walk in presence of an absorbing wall. *J. Statist. Phys.*, vol. 131, pp. 203–233 (2008).
- [90] B. DERRIDA, M. R. EVANS AND E. R. SPEER. Mean field theory of directed polymers with random complex weights. *Commun. Math. Phys.*, vol. 156, pp. 221–244 (1993).
- [91] B. DERRIDA, H. SPOHN. Polymers on disordered trees, spin glasses, and traveling waves. *Journal of Statistical Physics*, vol. 51, nos. 5/6, pp. 817–840 (1988).
- [92] L. DEVROYE. *Nonuniform Random Variate Generation*. Springer (1986).
- [93] P. DIACONIS. Some things we've learned (about Markov chain Monte Carlo). *Bernoulli*, vol. 19, no. 4, pp. 1294–1305 (2013).
- [94] P. DIACONIS, G. LEBEAU AND L. MICHEL. Gibbs/Metropolis algorithm on a convex polytope. *Math Zeitschrift*, vol. 272, no. 1, 109–129 (2012).
- [95] P. DIACONIS, G. LEBEAU AND L. MICHEL. Geometric analysis for the Metropolis algorithm on Lipschitz domains. *Invent. Math.*, vol. 185, no. 2, pp. 239–281 (2010).
- [96] P. DIACONIS, L. MICLO. On Characterizations of Metropolis type algorithms in continuous time. *Alea*, vol. 6, pp. 199–238 (2009).
- [97] P. DIACONIS, G. LEBEAU. Micro-local analysis for the Metropolis algorithm. *Mathematische Zeitschrift*, vol. 262, no. 2, pp. 441–447 (2009).
- [98] P. DIACONIS. The Markov chain Monte Carlo revolution. *Bull. Amer. Math. Soc.*, Nov. (2008).
- [99] P. DIACONIS, F. BASSETTI. Examples Comparing Importance Sampling and the Metropolis Algorithm. *Illinois Journal of Mathematics*, vol. 50, no. 1-4, pp. 67–91 (2006).
- [100] P. DIACONIS J. NEUBERGER. Numerical results for the Metropolis algorithm. *Experimental Math.*, vol. 13, no. 2, pp. 207–214 (2004).
- [101] P. DIACONIS, L. BILLERA. A geometric interpretation of the Metropolis-Hastings algorithm. *Statist. Sci.*, vol. 16, no. 4, pp. 335–339 (2001).

- [102] P. DIACONIS, A. RAM. Analysis of systematic scan Metropolis algorithms using Iwahori-Hecke algebra techniques. *Michigan Journal of Mathematics*, vol. 48, no. 1, pp. 157–190 (2000).
- [103] P. DIACONIS, L. SALOFF-COSTE. What do we know about the Metropolis algorithm? *Jour. Comp. System Sciences*, vol. 57, pp. 20–36 (1998).
- [104] P. DIACONIS, P. HANLON. Eigen-analysis for some examples of the Metropolis algorithm. *Contemporary Math.*, vol. 138, pp. 99–117 (1992).
- [105] P. DIACONIS, D. FREEDMAN. Iterated random functions. *SIAM Rev.*, vol. 41, pp. 45–76 (1999).
- [106] P. DIACONIS, R. GRAHAM. *Magical Mathematics*. Princeton University Press (2012).
- [107] P.J. DIGGLE *Statistical Analysis of Spatial Point Patterns* (2nd ed.). Academic Press (2003).
- [108] P. DIRAC. A new notation for quantum mechanics. *Mathematical Proceedings of the Cambridge Philosophical Society*, vol. 35, no. 3, pp. 416–418 (1939).
- [109] W. DOEBLIN. Exposé de la théorie des chaînes simples constantes de Markoff à un nombre fini d'états. *Revue Mathématique de l'Union Interbalkanique*, vol. 2, pp. 77–105 (1938).
- [110] R. DOUC, A. GARIVIER, E. MOULINES AND J. OLSSON. On the forward filtering backward smoothing particle approximations of the smoothing distribution in general state spaces models. *Annals of Applied Probab.*, vol. 21, no. 6, pp. 2109–2145 (2011).
- [111] A. DOUCET, N. DE FREITAS AND N. GORDON, EDITORS. *Sequential Monte Carlo Methods in Practice*. Statistics for Engineering and Information Science series. Springer (2001).
- [112] V. DRAKOPOULOS, N.P. NIKOLAOU. Efficient computation of the Hutchinson metric between digitized images. *IEEE Transactions on Image Processing*, vol. 13, no. 12 (2004).
- [113] R. ECKHARDT. Stam Ulam, John Von Neumann and the Monte Carlo method. *Los Alamos Science*, Special Issue: 131–136 (1987).
- [114] A. ECONOMOU. Generalized product-form stationary distributions for Markov chains in random environments with queueing applications. *Adv. in Appl. Probab.*, vol. 37, no. 1, pp. 185–211 (2005).
- [115] M. EGESDAL, C. FATHAUER, K. LOUIE AND J. NEUMAN. Statistical modeling of gang violence in Los Angeles, *SIAM Undergraduate Research Online*, 3 (2010).
- [116] P. EHRENFEST, T. EHRENFEST. Über zwei bekannte Einwände gegen das Boltzmannsche H-Theorem, *Phys. Z.*, vol. 8, pp. 311–314 (1907).
- [117] P. EMBRECHTS, H. SCHMIDLI. Ruin estimation for a general insurance risk model. *Advances in Applied Probability*, vol. 26, no. 2, pp. 404–422 (1994).
- [118] A. EINSTEIN. *Investigations on the Theory of the Brownian Movement*, Dover, New York (1956).

- [119] N. EL KAROUI, X. TAN. Capacities, Measurable Selection and Dynamic Programming Part I: Abstract framework. *ArXiv:1310.3363* (2014).
- [120] N. EL KAROUI, X. TAN. Capacities, Measurable Selection and Dynamic Programming Part II: Application in Stochastic Control Problems. *ArXiv:1310.3364* (2014).
- [121] N. ENRIQUEZ. Correlated Processes and the Composition of Generators. *Séminaire de Probabilités XL*, Springer, vol. 1899, pp. 329–342 (2007).
- [122] S. N. ETHIER. *The doctrine of chances. Probabilistic aspects of gambling.* Probability and its Applications series, Springer (2010).
- [123] S. N. ETHIER, T. G. KURTZ. *Markov Processes: Characterization and Convergence,* Wiley Series on Probability & Statistics (1986).
- [124] S.N. EVANS. Stochastic billiards on general tables. *Ann. Appl. Probab.*, vol. 11, no. 2, pp. 419–437 (2001).
- [125] P. A. FERRARI, N. MARIC. Quasi-stationary distributions and Fleming-Viot processes in countable spaces. *Electron. J. Probab.*, vol. 12, no. 24, pp. 684–702 (2007).
- [126] M. FIELD, M. GOLUBITSKY. *La symétrie du chaos, à la recherche des liens entre mathématiques et nature,* Inter-Éditions, Paris (1993).
- [127] R.A. FISHER. The wave of advance of advantageous genes. *Annals of Eugenics*, vol. 7, pp. 355–369 (1937).
- [128] R. FILLIGER, M.O. HONGLER. Supersymmetry in random two-velocity processes. *Physica A: Statistical Mechanics and its Applications*, vol. 332, no. 1. pp. 141–150 (2004).
- [129] J. FONTBONA, H. GUÉRIN AND F. MALRIEU. Quantitative estimates for the long-time behavior of an ergodic variant of the telegraph process. *Adv. in Appl. Probab.* vol. 44, no. 4, pp. 977–994 (2012).
- [130] J.-P. FOUCHE, L.-H. SUN. *Systemic Risk Illustrated: In Handbook on Systemic Risk,* Cambridge University Press (2013).
- [131] C.F. GAUSS. Theoria motus corporum coelestium in sectionibus conicis solem ambientum (1809).
- [132] C.F. GAUSS. Theoria combinationis observationum erroribus minimis obnoxiae (1821/1823).
- [133] S.B. GELFAND, S.K. MITTER. Weak convergence of Markov chain sampling methods and annealing algorithms to diffusions. *Journal of Optimization Theory and Applications*, vol. 68, no.3, pp. 483–498 (1991).
- [134] W. R. GILKS, S. RICHARDSON AND D. J. SPIEGELHALTER. *Markov Chain Monte Carlo in Practice.* Chapman-Hall/CRC Press (1996).
- [135] M. GIROLAMI, B. CALDERHEAD. Riemann manifold Langevin and Hamiltonian Monte Carlo methods. *Journal of the Royal Statistical Society: Series B*, vol. 73, no. 2, pp. 123–214 (2011).
- [136] S. GOLDSTEIN. On diffusion by discontinuous movements, and on the telegraph equation. *Quart. Journ. Mech. and Applied Math.*, vol. 4, no. 2, pp. 129–156 (1950).

- [137] T. GONZALES. *EVE: The Empyrean Age*. Orion books (2008).
- [138] F. GOSELIN. Asymptotic behavior of absorbing Markov chains conditional on non-absorption for applications in conservation biology. *Ann. Appl. Probab.*, vol. 11, pp. 261–284 (2001).
- [139] P. GRASSBERGER, A. DE LA TORRE. Reggeon field theory (Schlögl's first model) on a lattice: Monte Carlo calculation of critical behavior. *Ann. Phys.*, vol. 122, pp. 373–396 (1979).
- [140] J. GRIME. *Kruskal's count*. (Unpublished manuscript).
- [141] T.H. GRONWALL. Note on the derivatives with respect to a parameter of the solutions of a system of differential equations, *Ann. Math.*, vol. 20, no. 2, pp. 293–296 (1910).
- [142] HAIGHT F.A., *Handbook of the Poisson Distribution*, Wiley (1967).
- [143] M. HAIRER. Convergence of Markov processes. Lecture Notes, Warwick University (2010).
- [144] P.R. HALMOS. *Measure Theory*. Van Nostrand (1950).
- [145] T. HARA, G. SLADE. Self-avoiding walks in five or more dimensions: I. The critical behaviour. *Communications in Mathematical Physics*, vol. 147, pp. 101–136 (1992).
- [146] J. W. HARRIS, S.C HARRIS. Survival probability for branching Brownian motion with absorption. *Electron. Comm. Probab.*, vol. 12, pp. 89–100 (2007).
- [147] T. E. HARRIS, H. KAHN. Estimation of particle transmission by random sampling. *Natl. Bur. Stand. Appl. Math. Ser.*, vol. 12, pp. 27–30 (1951).
- [148] B. HAYES. Statistics of deadly quarrels. *American Scientist*, vol. 90: pp. 10–14, (2002).
- [149] A. HAWKES, L. ADAMPOULOS. Cluster models for earthquakes: regional comparisons. *Bull. Int. Statist. Inst.*, vol. 45, no. 3, pp. 454–461 (1973).
- [150] R. L. HERMAN. *A Course in Mathematical Methods for Physicists*. CRC Press (2013).
- [151] S. HERRMANN, J. TUGAUT. Non-uniqueness of stationary measures for self-stabilizing diffusions. *Stochastic Processes & Their Applications*, Vol. 120, no. 7, pp. 1215–1246 (2010).
- [152] A. HEUER, C. MÜLLER AND O. RUBNER. Soccer: Is scoring goals a predictable Poissonian process. *Europhysics Letters*, vol. 89, no. 3 (2010).
- [153] R.A. HOLLEY, T.M. LIGGETT. Ergodic theorems for weakly interacting infinite systems and the voter model. *Annals of Probability*, vol. 3, no. 4, pp. 643–663 (1975).
- [154] M.O. HONGLER. Exact soliton-like probability measures for interacting jump processes. [ArXiv:1501.07061](https://arxiv.org/abs/1501.07061) (2015).
- [155] V. JACOBSON Congestion avoidance and control. *Computer Communications Review*, vol. 18, no. 4, pp. 314–329 (1988).
- [156] P. JAGERS. *Branching Processes with Biological Applications*. Wiley (1975).
- [157] C. JARZYNSKI. Nonequilibrium equality for free energy differences. *Phys. Rev. Lett.*, vol. 78, 2690 (1997).

- [158] C. JARZYNSKI. Equilibrium free-energy differences from nonequilibrium measurements: A master-equation approach. *Phys. Rev. E*, vol. 56, 5018 (1997).
- [159] M. KAC. A stochastic model related to the telegrapher's equation. *Rocky Mountain Journal of Mathematics*, vol. 4, no. 3, pp. 497–509, (1974).
- [160] R. E. KALMAN. A new approach to linear filtering and prediction problems. *Trans. ASME Ser. D. J. Basic Engrg.*, vol. 82, pp. 35–45 (1960).
- [161] I. KARATZAS, S. E. SHREVE, *Brownian Motion and Stochastic Calculus*, Graduate Texts in Mathematics, Springer (2004).
- [162] S. KARLIN, H.M. TAYLOR. *A Second Course in Stochastic Processes*. Academic Press (1981).
- [163] E. HUTCHINSON. Fractals and self similarity. *Indiana University Mathematics Journal*, vol. 30, pp. 713–747 (1981).
- [164] R. E. KALMAN, R. S. BUCY. New results in linear filtering and prediction theory. *Trans. ASME Ser. D. J. Basic Engrg.*, vol. 83, pp. 95–108 (1961).
- [165] L. V. KANTOROVICH, G. S. RUBINSSTEIN. On a space of totally additive functions. *Vestnik Leningradskogo Universiteta*, vol. 13, no. 7, pp. 52–59, (1958).
- [166] J. KELLY. A new interpretation of information rate. *Bell Sys. Tech. J.*, vol. 35, pp. 917–926 (1956)
- [167] H. KESTEN. Branching Brownian motion with absorption. *Stochastic Process. and Appl.*, vol. 37, pp. 9–47 (1978).
- [168] J. F. C. KINGMAN. The first birth problem for age dependent branching processes. *Ann. Probab.*, vol. 3, pp. 790–801 (1975).
- [169] P. E. KLOEDEN, E. PLATEN AND N. HOFMANN. Extrapolation methods for the weak approximation of Itô diffusions. *SIAM Journal on Numerical Analysis*, vol. 32, no. 5, pp. 1519–1534 (1995).
- [170] P. E. KLOEDEN, E. PLATEN. *Numerical Solution of Stochastic Differential Equations*, vol. 23, Springer (2011).
- [171] P. E. KLOEDEN, E. PLATEN. A survey of numerical methods for stochastic differential equations. *Stochastic Hydrology and Hydraulics*, vol. 3, no. 5, pp. 155–178 (1989).
- [172] P. R. KILLEEN, J. G. FETTERMAN. A behavioral theory of timing. *Psychological Review*, vol. 95, no. 2, pp. 274–295 (1988).
- [173] A.N. KOLMOGOROV, I.G. PETROVSKII AND N.S. PISKUNOV. A study of the diffusion equation with increase in the amount of substance, and its application to a biological problem, *Bull. Moscow Univ. Math. Mech.*, vol. 1, no. 6, pp. 1–26 (1937).
- [174] H.J. KUSHNER. On the weak convergence of interpolated Markov chains to a diffusion, *Annals of Probability*, vol. 2, pp. 40–50 (1974).
- [175] O. KRAFFT, M. SCHAEFER. Mean passage times for tridiagonal transition matrices and a two-parameter Ehrenfest urn model. *J. Appl. Prob.*, vol. 30: 964–970 (1993).
- [176] J. F. LAGARIAS, E. BAINS AND R. J. VANDERBEI. The Kruskal count. ArXiv:math/0110143v1 (2001).

- [177] Y.F. LEE, W.K. CHING. On the convergent probabilities of a random walk. *International Journal of Mathematical Education in Science and Technology*, vol. 37, no. 7 (2006).
- [178] A.M. LEGENDRE. *Nouvelles méthodes pour la détermination des orbites des comètes*. Firmin Didot, Paris (1805).
- [179] O. HERNANDEZ-LERMA, J.B. LASSEUR. *Further topics on discrete-time Markov control processes*. Springer, Application of Mathematics. Stochastic modeling and Applied Probability series, vol. 42 (1999).
- [180] C. LIANG, G. CHENG, D. L. WIXON AND T. C. BALSER. An absorbing Markov chain approach to understanding the microbial role in soil carbone stabilization. *Bio-geochemistry*, vol. 106, pp. 303–309 (2011).
- [181] S. LEE, J. R. WILSON AND M. CRAWFORD. Modeling and simulation of a non-homogeneous Poisson process having cyclic behavior. *Communications in Statistics, Simulation*, vol. 20, pp. 777–809 (1991).
- [182] D. A. LEVIN, Y. PERES. *Markov Chains and Mixing Times*. American Mathematical Society (2008).
- [183] T. M. LIGGETT. *Interacting Particle Systems*. Springer (1985).
- [184] T. M. LIGGETT. *Stochastic Interacting Systems: Contact, Voter and Exclusion Processes*. Springer (1999).
- [185] J. LUCZKA, R. RUDNICKI. Randomly flashing diffusion: asymptotic properties, *J. Statist. Phys.*, vol. 83, pp. 1149–1164 (1996).
- [186] F. MALRIEU. Some simple but challenging Markov processes. [ArXiv:1412.7516](https://arxiv.org/abs/1412.7516), dec. (2014).
- [187] H. P. MCKEAN. Application of Brownian motion to the equation of Kolmogorov-Petrovskii-Piskunov, *Communications on Pure and Applied Mathematics*, vol. 28, pp. 323–331 (1975).
- [188] H. P. MCKEAN. H.P. McKean, A correction to "Application of Brownian motion to the equation of Kolmogorov-Petrovskii-Piskunov", *Comm. Pure Appl. Math.*, vol. 29, pp. 553–554 (1976).
- [189] H. MAHMOUD. *Polya Urn Models*. Chapman & Hall/CRC. Texts in Statistical Science (2009).
- [190] B. MANDELBROT, *The Fractal Geometry of Nature*. W.H. Freeman & Co. (1982).
- [191] J. C. MATTINGLY, A. M. STUART, AND D. J. HIGHAM. Ergodicity for SDEs and approximations: locally Lipschitz vector fields and degenerate noise. *Stochastic Process. Appl.*, vol. 101, no. 2, pp. 185–232 (2002).
- [192] E. LEWIS, G. MOHLER, P. J. BRANTINGHAM AND A. BERTOZZI. Self-exciting point process models of civilian deaths in Iraq. *Security Journal*, vol. 25, pp. 244–264 (2011).
- [193] J. MACQUEEN, R. G. MILLER JR. Optimal persistence policies, *Oper. Res.*, vol. 8, pp. 362–380 (1960).

- [194] R.C. MERTON. Theory of rational option pricing. *Bell Journal of Economics and Management Science*, vol. 4, no. 1, pp. 141–183 (1973).
- [195] A. R. MESQUITA. Exploiting Stochasticity in Multi-agent Systems, PhD thesis, University of California, Santa Barbara (2010).
- [196] N. METROPOLIS, S. ULAM. The Monte Carlo Method. *Journal of the American Statistical Association*, Vol. 44, No. 247, pp. 335–341 (1949).
- [197] N. METROPOLIS. The beginning of the Monte Carlo method. *Los Alamos Science*, no. 15, pp. 125–130 (1987).
- [198] N. METROPOLIS, A.W. ROSENBLUTH, M.N. ROSENBLUTH, A.H. TELLER AND E. TELLER. Equation of state calculations by fast computing machines. *Journal of Chemical Physics*, vol. 21, no. 6, pp. 1087–1092 (1953).
- [199] S. P. MEYN, R.L. TWEEDIE. *Markov Chains and Stochastic Stability*. Springer (1993).
- [200] B. MEZRICH. *Bringing Down the House: The Inside Story of Six M.I.T. Students Who Took Vegas for Millions*, Free Press (2002).
- [201] J. MICHAEL. Positive and negative reinforcement, a distinction that is no longer necessary; or a better way to talk about bad things. *Behaviorism*, vol. 3, no. 1, pp. 33–44 (1975).
- [202] L. MLODINOW. *The Drunkard's Walk: How Randomness Rules Our Lives*. Edition Pantheon (2008).
- [203] G. O. MOHLERA, M. B. SHORTA, P. J. BRANTINGHAMA, F. P. SCHOENBERGA AND G. E. TITA. Self-exciting point process modeling of crime. *Journal of the American Statistical Association*, vol. 106, no. 493 (2011).
- [204] L. MOSER. On a problem of Cayley, *Scripta Math.*, vol. 22, pp. 289–292 (1956).
- [205] M.E. MÜLLER. Some continuous Monte Carlo methods for the Dirichlet problem. *Ann. Math. Stat.*, vol. 27, pp. 569–589 (1956).
- [206] J. NEVEU. Multiplicative martingales for spatial branching processes. In *Seminar on Stochastic Processes, 1987. Prog. Probab. Statist.* vol. 15, pp. 223–241. Birkhäuser, Boston (1988).
- [207] Y. NISHIYAMA. The Kruskal principle. *Osaka Keidai Ronshu*, vol. 63, no. 3 (2012).
- [208] F. POHL, J. BERKEY. *Drunkard's Walk*. Ballantine Books (1973).
- [209] I. M. TOKE, F. POMPONIO. Modelling trades-through in a limit order book using Hawkes Processes. *Economics*, vol. 6, no. 2012-22, (2012).
- [210] J. NORRIS. *Markov Chains*. Cambridge University Press (1998).
- [211] Y. OGATA, D. VERE-JONES. Inference for earthquake models: A self-correcting model. *Stochastic Processes and their Applications*, vol. 17, no. 2, pp. 337-347 (1984).
- [212] Y. OGATA. Statistical models for earthquake occurrences and residual analysis for point processes. *J. Amer. Statist. Assoc.*, vol. 83, pp. 9–27 (1988).

- [213] B. K. ØKSENDAL. *Stochastic Differential Equations: An Introduction with Applications*, 6th ed. Springer (2003).
- [214] L.S. ORNSTEIN, G.E. UHLENBECK. On the theory of Brownian motion. *Phys. Rev.*, vol. 36, pp. 823–841 (1930).
- [215] T. J. OTT, J. H. B. KEMPERMAN. Transient behavior of processes in the TCP paradigm. *Probab. Engrg. Inform. Sci.*, vol. 22, no.3, pp. 431–471 (2008),
- [216] T. J. OTT, J. H. B. KEMPERMAN AND M. MATHIS. The stationary behavior of ideal TCP congestion avoidance. Unpublished manuscript : available at <http://www.teunisott.com/>, 1996.
- [217] M. PACE, P. DEL MORAL. Mean-field PHD filters based on generalized Feynman-Kac flow. *IEEE Journal of Selected Topics in Signal Processing*, vol. 7, no. 3, pp. 484-495 (2013).
- [218] L. PAGE, S. BRIN. The anatomy of a large-scale hypertextual web search engine. *Computer Networks and ISDN Systems*, vol. 30, pp. 107–117 (1998).
- [219] LARRY PAGE AND SERGEY BRIN. Encyclopedia of World Biography. Advameg, Inc. 2013.
- [220] L. PAGE. PageRank: Bringing Order to the Web, Stanford Digital Library Project talk. August 18, 1997.
- [221] J.M.R. PARRONDO, L. DINIS. Brownian motion and gambling: from ratchets to paradoxical games. *Contemporary Physics*, vol. 45, no. 2, pp. 147–157 (2004).
- [222] E. A. J. F. PETERS, G. DE WITH. Rejection-free Monte-Carlo sampling for general potentials. *Physical Review E* 85.026703 (2012).
- [223] V. M. PILLAI, M. P. CHANDRASEKHARAN. An absorbing Markov chain model for production systems with rework and scrapping. *Computers and Industrial Engineering*, vol. 55, no. 3, pp. 695–706 (2008).
- [224] V. PLACHOURAS, I. OUNIS, AND G. AMATI. The static absorbing model for hyperlink analysis on the web. *Journal of Web Engineering*, vol. 4, no. 2, pp. 165–186 (2005).
- [225] S. PINKER. *How The Mind Works*. W. W. Norton & Company, pp. 54–55 (2009).
- [226] E. PLATEN, K. KUBILIUS. Rate of weak convergence of the Euler approximation for diffusion processes with jumps. School of Finance and Economics, University of Technology, Sydney (2001).
- [227] J. POSTEL. Transmission Control Protocol, September 1981, RFC 793 (1981).
- [228] N. PRIVAULT. *Notes on Markov chains*. Nanyang Technological University (2012).
- [229] T. RAINSFORD, A. BENDER. Markov approach to percolation theory based propagation in random media. *IEEE Transactions on Antennas and Propagation*, vol. 56, no. 3, pp. 1402–1412, (2008).
- [230] N. RATANOV. Double telegraph processes and complete market models. *Stoch. Anal. Appl.*, vol. 32, no. 4, pp. 555–574 (2014).
- [231] D. REVUZ, M. YOR. *Continuous Martingales and Brownian Motion*, Springer (1991).

- [232] G. O. ROBERTS, R. L. TWEEDIE. Exponential convergence of Langevin distributions and their discrete approximations. *Bernoulli*, vol. 2, pp. 341–363 (1996).
- [233] G. O. ROBERTS, R. L. TWEEDIE. Geometric convergence and central limit theorems for multi-dimensional Hastings and Metropolis algorithms. *Biometrika*, vol. 83, no. 1, pp. 95–110 (1996).
- [234] S. M. ROSS. *Introduction to stochastic dynamic programming*. Academic Press. Probability and Mathematical Statistics Series (1983).
- [235] R. RUDNICKI. Markov operators: applications to diffusion processes and population dynamics. *Applicationes Mathematicae*, vol. 27, no. 1, pp. 67–79 (2000).
- [236] L. SALOFF-COSTE. *Lectures on Finite Markov Chains*. École d’été de Saint Flour, Springer (1996).
- [237] J. SANDEFUR. The gunfight at the OK corral. *Mathematics Magazine*, vol. 62, no. 2, pp. 119–124 (1989).
- [238] E. SCHRÖDINGER. An undulatory theory of the mechanics of atoms and molecules. *Physical Review*, vol. 28, no. 6, pp. 1049–1070 (1926).
- [239] E. SENETA. *Non-negative Matrices and Markov Chains*. Springer (2006).
- [240] SINGER, R.A. Estimating optimal tracking filter performance for manned maneuvering targets. *IEEE Transactions on Aerospace and Electronic Systems*, vol. 6, no. 4, pp. 473–483 (1970).
- [241] D. SHERRINGTON, S. KIRKPATRICK. Solvable model of a spin-glass, *Physics Review Letters*, vol. 35, no. 26, pp. 1792–1796 (1975).
- [242] Z. SHI. *Branching Random Walks*. École d’été de Probabilités de Saint Flour, Springer (2012).
- [243] M.B. SHORT, M. R. D’ORSOGNA, P.J. BRANTINGHAM AND G.E. TITA. Measuring and modeling repeat and near-repeat burglary effects, *J. Quant. Criminol.*, vol. 25, no. 3, 325–339 (2009).
- [244] M. SMOLUCHOWSKI. Zur kinetischen Theorie der Brownschen Molekularbewegung und der Suspensionen. *Annalen der Physik*, vol. 21, no. 14, pp. 756–780 (1906).
- [245] F. SPITZER. Interaction of Markov processes. *Advances in Mathematics*, vol. 5, pp. 246–290 (1970).
- [246] R. L. STRATONOVICH. Conditional Markov processes. *Theory of Probability and Its Applications*, vol. 5, pp. 156–178 (1960).
- [247] D. STEINSALTZ, S. N. EVANS. Markov mortality models: implications of quasi-stationarity and varying initial distributions. *Theor. Pop. Biol.*, vol. 65, pp. 319–337 (2004).
- [248] L. M. SURHONE, M. T. TENNOE AND S. F. HENSSONOW. *Hutchinson Metric*. Betascript Publishing (2010).
- [249] R.S. SUTTON, A.G. BARTO. *Reinforcement Learning: An Introduction*. MIT Press (1998).

- [250] W.C. SWOPE, H.C. ANDERSEN, P.H. BERENS AND K. WILSON. A computer simulation method for the calculation of equilibrium constants for the formation of physical clusters of molecules: applications to small water clusters. *J. Chem. Phys.*, vol. 76, pp. 637–649 (1982).
- [251] F. THORNDIKE. Applications of Poisson's probability summation. *Bell System Technical Journal*, vol. 5, no. 4, pp. 604–624 (1926).
- [252] N. TOUZI. *Optimal Stochastic Control, Stochastic Target Problems and Backward SDE*. The Fields Institute for Research Springer (2013).
- [253] M. D. TOWLER. Quantum Monte Carlo and the CASINO program: highly accurate total energy calculations for finite and periodic systems. *Psi-k Newsletter* December (2003).
- [254] O. VASICEK. An equilibrium characterisation of the term structure. *Journal of Financial Economics*, vol. 5, no. 2, pp. 177–188 (1977).
- [255] P.G.C. VASSILIOU. The evolution of stochastic mathematics that changed the financial world. *Linear Algebra and its applications*, vol. 203-204, pp. 1-66 (1994).
- [256] C. VERGE, C. DUBARRY, P. DEL MORAL AND E. MOULINES. On parallel implementation of sequential Monte Carlo methods: the island particle model. *Statistics and Computing*, vol. 25, no. 2, pp. 243–260 (2015).
- [257] L. VERLET. Computer experiments on classical fluids. I. Thermodynamical properties of Lennard-Jones Molecules. *Physical Review*, vol. 159, pp. 98–103. (1967).
- [258] C. VILLANI. *Topics in Optimal Transportation*. Volume 58, Graduate Studies in Mathematics. American Mathematical Society (2003).
- [259] J. VILLE. *Étude critique de la notion de collectif*, Monographies des Probabilités 3 (in French), Paris: Gauthier-Villars (1939).
- [260] F.W. WARNER. *Foundations of Differentiable Manifolds and Lie Groups*. Scott, Foresman and Co. (1971).
- [261] J. WEINGARTEN. Ueber eine Klasse auf einander abwickelbarer Flächen. *Journal für die reine und angewandte Mathematik*, vol. 59, pp. 382–393 (1861).
- [262] K. Wolny. Geometric ergodicity of heterogeneously scaled Metropolis-adjusted Langevin algorithms (MALA). Seventh Workshop on Bayesian Inference in Stochastic Processes (BISP 2011), Madrid (2011).
- [263] J. R. YOUNG. The Magical Mind of Persi Diaconis. Chronicle of Higher Education, October 16th (2011).
- [264] L. ZHANG. Virtual-Clock: A new traffic control algorithm for packet switching networks. *ACM SIGCOMM Proc. Computer Communication Review*, vol. 20, no. 4, pp. 19–29 (1990).
- [265] L. ZHANG AND S. DAI. Application of Markov model to environment fate of phenanthrene in Lanzhou reach of Yellow river. *Chemosphere*, vol. 67, pp. 1296–1299 (2007).



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