

## David Rushing Dewhurst

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## Professional Experience

*Scientist, Charles River Analytics: August 2020 – present*

- **PI** on DARPA I2O **ECoSystemic** (eventual consistency in federated financial systems), **MIPs** (modeling influence pathways); Co-PI on DARPA DSO **EDGE** (enhanced situational awareness in autonomous systems control); Modeling team lead on DARPA STO LogX (joint logistics enterprise forecasting) and DARPA MTO SHEATH (hardware trojan horse detection); Lead scientist on DEVCOM and NAVSEA cybersecurity efforts
- Lead capture efforts across multiple business initiatives (supply chain/logistics and sustainment; deployment of probabilistic programming) and government partners (DARPA I2O, STO, BTO; AFLCMC)
- Designed/implemented four universal probabilistic programming languages and probabilistic graphical model library; designed/implemented corporate financial forecasting toolkit

*Lead Data Scientist, MassMutual: February 2020 – August 2020*

- Designed/implemented automated economic capital risk management system
- Architect and develop comprehensive Bayesian structural time series software

*Computer Science Graduate Fellow, MITRE Corporation: June 2017 – September 2019*

- Design and implement digital signal processing algorithms for petabyte-scale financial transaction analysis, author empirical studies of US equities market microstructure
- Facilitate financial resilience tabletop exercises (joint with DARPA and NY Fed)
- Received Trailblazer award for establishing new company initiative in computational finance

## Education

*PhD (February 2020) – University of Vermont: Complex Systems and Data Science*

- 100% funded: DARPA #W56KGU-17-C-0010 (2018 – 2019); MassMutual (2019 – 2020)

*MS (May 2018) – University of Vermont: Mathematics*

- 100% funded: GTA (2017), DARPA #W56KGU-17-C-0010 (2017 – 2018)

*Séminaire de Mathématiques Supérieures (July 2017) –MSRI/University of Montreal*

- 100% funded: MSRI scholarship

*BA (May 2016) – University of Vermont: Economics, Mathematics, and Political Science*

## Interests

*Grey-zone/hybrid conflict*

- **Resilient financial systems:** automated cross-subsystem failure mode identification, resilient trading and settlement mechanisms, pure financial strategies to counter financial attacks
- **Cognitive warfare:** detecting, categorizing, and mitigating influence operations and cognitive hijacking in elections, media, and other environments

- **Logistics:** enabling reliable demand signals in austere/low-resource environments

#### *Distributed statistical edge computing*

- asynchronous inference of system-wide latent state using many small local models (e.g., as applied to logistics demand estimation or cyberattack detection and characterization)
- scaling down open-world probabilistic programming to low-resource environments
- Unconventional sensing and forecasting using financial market, commercial logistics, and social media data

#### *Knowledge representation*

- creating consistent, adaptive, useful, and human-oriented typologies from extremely limited data (e.g., human conversation or email exchange with minimal background information)

## Papers

(Time ordering is first appearance on arXiv.org if it appeared there, otherwise date of publication, descending order. C – at Charles River; M – at MassMutual; U – at university.)

1. Van Oort, C.M., Ring IV, J.H., **Dewhurst, D.R.**, Danforth, C.M. and Tivnan, B.F., 2022. Ecological and Coevolutionary Dynamics in Modern Markets Yield Nonstationarity in Market Efficiencies. *Complexity*, 2022. **(C)**
2. Inman, J., Wright, J., Martino, R., Gale, M., Rogers, C., Dora, R., Mitchell, D., Gupta, N., **Dewhurst, D.**, Summerville, D., 2021. FALCHION: Fuzzing Automatically to Locate Compromised Hardware with Isolation to Omit Noise. In Proceedings of GOMACTech 2021, Virtual. 2021. **(C)**
3. **Dewhurst, D.R.**, 2020. Structural time series grammar over variable blocks. arXiv preprint arXiv:2009.06865. Presented at ProbProg 2020. **(C)**
4. Dodds, P.S., Minot, J.R., Arnold, M.V., Alshaabi, T., Adams, J.L., **Dewhurst, D.R.**, Reagan, A.J., and Danforth, C.M., 2020. Probability-turbulence divergence: A tunable allotaxonomic instrument for comparing heavy-tailed categorical distributions. arXiv preprint arXiv:2008.13078. (Submitted for publication.) **(M)**
5. Dodds, P.S., Minot, J.R., Arnold, M.V., Alshaabi, T., Adams, J.L., **Dewhurst, D.R.**, Reagan, A.J., and Danforth, C.M., 2020. Long-term word frequency dynamics derived from Twitter are corrupted: A bespoke approach to detecting and removing pathologies in ensembles of time series. arXiv preprint arXiv:2008.11305. **(M)**
6. Alshaabi, T., Adams, J.L., Arnold, M.V., Minot, J.R., **Dewhurst, D.R.**, Reagan, A.J., Danforth, C.M. and Dodds, P.S., 2021. Storywrangler: A massive exploratorium for sociolinguistic, cultural, socioeconomic, and political timelines using Twitter. *Science advances*, 7(29), p.eabe6534. **(M)**
7. Alshaabi, T., **Dewhurst, D.R.**, Bagrow, J.P., Dodds, P.S. and Danforth, C.M., 2021. The sociospatial factors of death: Analyzing effects of geospatially distributed variables in a Bayesian mortality model for Hong Kong. *Plos one*, 16(3), p.e0247795. **(M)**
8. **Dewhurst, D.R.**, Alshaabi, T., Arnold, M.V., Minot, J.R., Danforth, C.M. and Dodds, P.S., 2020. Divergent modes of online collective attention to the COVID-19 pandemic are associated with future caseload variance. arXiv preprint arXiv:2004.03516. **(M)**

9. Arnold, M.V., **Dewhurst, D.R.**, Alshaabi, T., Minot, J.R., Adams, J.L., Danforth, C.M. and Dodds, P.S., 2021. Hurricanes and hashtags: Characterizing online collective attention for natural disasters. *PLoS one*, 16(5), p.e0251762. **(M)**
10. Alshaabi, T., Arnold, M.V., Minot, J.R., Adams, J.L., **Dewhurst, D.R.**, Reagan, A.J., Muhamad, R., Danforth, C.M., and Dodds, P.S., 2020. How the world's collective attention is being paid to a pandemic: COVID-19 related 1-gram time series for 24 languages on Twitter. *PLoS one* 16, no. 1 (2021): e0244476. **(M)**
11. Alshaabi, T., **Dewhurst, D.R.**, Minot, J.R., Arnold, M.V., Adams, J.L., Danforth, C.M. and Dodds, P.S., 2021. The growing amplification of social media: measuring temporal and social contagion dynamics for over 150 languages on Twitter for 2009–2020. *EPJ data science*, 10(1), pp.1-28. **(M)**
12. Dodds, P.S., Minot, J.R., Arnold, M.V., Alshaabi, T., Adams, J.L., **Dewhurst, D.R.**, Gray, T.J., Frank, M.R., Reagan, A.J. and Danforth, C.M., 2020. Allotaxonomy and rank-turbulence divergence: A universal instrument for comparing complex systems. *arXiv preprint arXiv:2002.09770*. (Submitted for publication.) **(M)**
13. **Dewhurst, D.R.**, Li, Y., Bogdan, A. and Geng, J., 2020, July. Evolving *ab initio* trading strategies in heterogeneous environments. In *Proceedings of the 2020 Genetic and Evolutionary Computation Conference* (pp. 76-84). **(M)**
14. Dodds, P.S., Minot, J.R., Arnold, M.V., Alshaabi, T., Adams, J.L., **Dewhurst, D.R.**, Reagan, A.J. and Danforth, C.M., 2019. Fame and Ultrafame: Measuring and comparing daily levels of being “talked about” for United States’ presidents, their rivals, God, countries, and K-pop. *arXiv preprint arXiv:1910.00149*. (Submitted for publication.) **(U)**
15. **Dewhurst, D.R.**, Danforth, C.M. and Dodds, P.S., 2020. Noncooperative dynamics in election interference. *Physical Review E*, 101(2), p.022307. **(U)**
16. **Dewhurst, D.R.**, Alshaabi, T., Kiley, D., Arnold, M.V., Minot, J.R., Danforth, C.M. and Dodds, P.S., 2020. The shocklet transform: a decomposition method for the identification of local, mechanism-driven dynamics in sociotechnical time series. *EPJ Data Science*, 9(1), p.3. **(U)**
17. **Dewhurst, D.R.**, Arnold, M.V. and Van Oort, C.M., 2019, July. Selection mechanisms affect volatility in evolving markets. In *Proceedings of the Genetic and Evolutionary Computation Conference* (pp. 90-98). *ACM*. **(U)**
18. **Dewhurst, D.R.**, Van Oort, C.M., Ring IV, J.H., Gray, T.J., Danforth, C.M. and Tivnan, B.F., 2019. Scaling of inefficiencies in the US equity markets: Evidence from three market indices and more than 2900 securities. *arXiv preprint arXiv:1902.04691*. (Submitted for publication.) **(U)**
19. Tivnan, B.F., **Dewhurst, D.R.**, Van Oort, C.M., Ring IV, J.H., Gray, T.J., Tivnan, B.F., Koehler, M.T., McMahon, M.T., Slater, D.M., Veneman, J.G. and Danforth, C.M., 2020. Fragmentation and inefficiencies in US equity markets: Evidence from the Dow 30. *PLoS one*, 15(1), p.e0226968. **(U)**
20. **Dewhurst, D.R.**, Danforth, C.M. and Dodds, P.S., 2018. Continuum rich-get-richer processes: Mean field analysis with an application to firm size. *Physical Review E*, 97(6), p.062317. **(U)**

21. Dodds, P.S., **Dewhurst, D.R.**, Hazlehurst, F.F., Van Oort, C.M., Mitchell, L., Reagan, A.J., Williams, J.R. and Danforth, C.M., 2017. Simon's fundamental rich-get-richer model entails a dominant first-mover advantage. *Physical Review E*, 95(5), p.052301. **(U)**

## Talks

1. **Dewhurst, D.R.** (September, 2022). Operationalizing open-world probabilistic programming at the edge. Presented at the Military Operations Research Society (MORS) Emerging Techniques Forum (ETF), Institute for Defense Analyses, Alexandria, VA, USA.
2. Fry, G. and **Dewhurst, D.R.** (July, 2022). [Title redacted]. Presented at the Malware Technical Exchange Meeting (MTEM), MIT Lincoln Laboratory, Lexington, MA, USA.
3. **Dewhurst, D.R.** (June, 2022). Rapid exact restoration of federated market state after systemic failure. Presented at the 90<sup>th</sup> Military Operations Research Society (MORS) Symposium, Marine Corps University, Quantico, VA, USA.
4. **Dewhurst, D.R.** (July, 2020). Evolving *ab initio* trading strategies in heterogeneous environments. Presented at the Genetic and Evolutionary Computational Conference (GECCO 2020), Remote.
5. **Dewhurst, D.R.** (January, 2020). The shocklet transform and STAR algorithm: A decomposition method for the identification of local, mechanism-driven dynamics in sociotechnical time series. Presented at Dynamics Days 2020, Hartford, CT, USA.
6. **Dewhurst, D.R.** (July, 2019). Selection mechanisms affect volatility in a market of evolving agents. Presented at the Genetic and Evolutionary Computation Conference (GECCO 2019), Prague, Czech Republic.
7. **Dewhurst, D.R.** (May, 2019). Fragmentation and inefficiencies in US equities markets: A network perspective. Presented at the 4th workshop on Statistical Physics for Financial and Economic Networks at NetSci 2019, Burlington, VT, USA.