

# Forrest W. Crawford

Yale School of Public Health  
Department of Biostatistics  
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## Education

- 2012 PhD Biomathematics, University of California Los Angeles  
Advisor: Marc A. Suchard
- 2009 MS Biomathematics, University of California Los Angeles
- 2002 BA Neuroscience, Oberlin College

## Academic Positions

- 2017- *Associate Professor*, Department of Biostatistics, Yale School of Public Health  
Secondary Appointment, Department of Ecology and Evolutionary Biology  
Secondary Appointment, Yale School of Management (Operations)  
Other Yale affiliations: Center for Interdisciplinary Research on AIDS, Computational Biology and Bioinformatics inter-departmental program, Institute for Network Science, Public Health Modeling Concentration
- 2012-2017 *Assistant Professor*, Department of Biostatistics, Yale School of Public Health

## Publications

- [1] G S Gonsalves and **Forrest W. Crawford**. “Dynamics of the HIV outbreak and response in Scott County, Indiana, 2011-2015: a modelling study.” *The Lancet HIV* **5** (2018).
- [2] G S Gonsalves and **Forrest W. Crawford**. “Lessons learned from the Indiana HIV outbreak.” *HIV Specialist* **10** (2018).
- [3] P M Aronow, **Forrest W. Crawford**, and J R Zubizarreta. “Confidence intervals for linear unbiased estimators under constrained dependence.” *Electronic Journal of Statistics* **12**, 2238–2252 (2018).
- [4] J Wu, **Forrest W. Crawford**, D A Kim, D Stafford, and N A Christakis. “Exposure, hazard, and survival analysis of diffusion on social networks.” *Statistics in Medicine* **37**, 2561–2585 (2018). (Received 2017 WNAR Outstanding Written Paper Award.).
- [5] Y Liu and **Forrest W. Crawford**. “Estimating dose-specific cell division and apoptosis rates from chemo-sensitivity experiments.” *Scientific Reports* **8**, 1–8 (2018).
- [6] L S Ho, **Forrest W. Crawford**, and M A Suchard. “Direct likelihood-based inference for discretely observed stochastic compartmental models of infectious disease.” *Annals of Applied Statistics* **12**, 1993–2021 (2018).
- [7] O Morozova, T Cohen, and **Forrest W. Crawford**. “Risk ratios for contagious outcomes.” *Journal of the Royal Society Interface* **15**, 20170696 (2018).
- [8] **Forrest W. Crawford**, L S Ho, and M A Suchard. “Computational methods for birth-death processes.” *Wiley Interdisciplinary Reviews Computational Statistics* **10**, e1423 (2018).

- [9] **Forrest W. Crawford**, P M Aronow, L Zeng, and J Li. “Identification of homophily and preferential recruitment in respondent-driven sampling.” *American Journal of Epidemiology* **187**, 153–160 (2018).
- [10] J E Pachankis, M L Hatzenbuehler, K Wang, C L Burton, **Forrest W. Crawford**, J C Phelan, and B G Link. “The Burden of Stigma on Health and Wellbeing: A Taxonomy of Concealment, Course, Disruptiveness, Aesthetics, Origin, and Peril across 93 Stigmas.” *Personality and Social Psychology Bulletin* **44**, 451–474 (2018).
- [11] L S Ho, J Xu, **Forrest W. Crawford**, V N Minin, and M A Suchard. “Birth(death)/birth-death processes and their computable transition probabilities with biological applications.” *Journal of Mathematical Biology* **76**, 911–944 (2018).
- [12] G S Gonsalves, **Forrest W. Crawford**, P D Cleary, E H Kaplan, and A D Paltiel. “An Adaptive Approach to Locating Mobile HIV Testing Services.” *Medical Decision Making* **38**, 262–272 (2018).
- [13] **Forrest W. Crawford**, J Wu, and R Heimer. “Hidden population size estimation from respondent-driven sampling: a network approach.” *Journal of the American Statistical Association* **113**, 755–766 (2018).
- [14] Alexander R. Bazazi, Aishwarya Vijay, **Forrest W. Crawford**, Robert Heimer, Adeeba Kamarulzaman, and Frederick L. Altice. “HIV testing and awareness of HIV status among people who inject drugs in Greater Kuala Lumpur, Malaysia.” *AIDS Care* **30**, 59–64 (2018).
- [15] J Wu, **Forrest W. Crawford**, M Raag, R Heimer, and A Uusküla. “Using data from respondent-driven sampling to estimate the number of people who inject drugs, with application to the Kohtla-Järve region of Estonia.” *PLoS One* **12**, e0185711 (2017).
- [16] R Heimer, R Barbour, D Khoury, **Forrest W. Crawford**, F Shebl, E Aaraj, and K Khoshnood. “HIV Risk, Prevalence, and Access to Care among Men Who Have Sex with Men in Lebanon.” *AIDS Research and Human Retroviruses* **33**, 1149–1154 (2017).
- [17] L Chen, **Forrest W. Crawford**, and A Karbasi. “Submodular Variational Inference for Network Reconstruction.” *Proceedings of the Conference on Uncertainty in Artificial Intelligence (UAI)* (2017).
- [18] G J Culbert, **Forrest W. Crawford**, A Murni, A Waluyo, A R Bazazi, J Sahar, and F L Altice. “Predictors of Mortality within Prison and after Release among Persons Living with HIV in Indonesia.” *Research and Reports in Tropical Medicine* **8**, 25–35 (2017).
- [19] M Antillón, J L Warren, **Forrest W. Crawford**, D M Weinberger, E Kuruñ, G D Pak, J K Park, F Marks, and V E Pitzer. “The burden of typhoid fever in low- and middle-income countries: a meta-regression approach.” *PLoS Neglected Tropical Diseases* **11**, e0005376 (2017).
- [20] **Forrest W. Crawford**. “The graphical structure of respondent-driven sampling.” *Sociological Methodology* **46**, 187–211 (2016).
- [21] A Kunkel, **Forrest W. Crawford**, J Shepherd, and T Cohen. “Benefits of continuous isoniazid preventive therapy may outweigh resistance risks in a declining TB/HIV co-epidemic.” *AIDS* **30** (2016).
- [22] L Chen, A Karbasi, and **Forrest W. Crawford**. “Estimating the size of a large network and its communities from a random sample.” *Advances in Neural Information Processing Systems* **29** (2016).
- [23] **Forrest W. Crawford**. “Discussion of “Co-authorship and citation networks for statisticians” by Pengsheng Ji and Jiashun Jin.” *Annals of Applied Statistics* **10** (2016).
- [24] **Forrest W. Crawford**, TC Stutz, and K Lange. “Coupling bounds for approximating birth-death processes by truncation.” *Statistics and Probability Letters* **109**, 30–38 (2016).
- [25] V Pitzer, J Bilcke, E Heylen, **Forrest W. Crawford**, M Van Ranst, M Zeller, and J Matthijnsens. “Did Large-Scale Vaccination Drive Changes in the Circulating Rotavirus Population in Belgium?”

*Scientific Reports* **5**, 18585 (2015).

- [26] L Chen, **Forrest W. Crawford**, and A Karbasi. “Seeing the Unseen Network: Inferring Hidden Social Ties from Respondent-Driven Sampling.” *In Proceedings of The 30th AAAI Conference on Artificial Intelligence and the 28th Innovative Applications of Artificial Intelligence Conference*, volume 30 (2015).
- [27] A R Bazazi, **Forrest W. Crawford**, A Zelenev, R Heimer, A Kamarulzaman, and F L Altice. “HIV prevalence among people who inject drugs in Malaysia: a respondent-driven sampling study in Greater Kuala Lumpur.” *AIDS & Behavior* **19**, 2347–2357 (2015).
- [28] **Forrest W. Crawford**. “Hidden network reconstruction from information diffusion.” *In 18th International Conference on Information Fusion*, pp. 180–185 (2015).
- [29] PM Aronow, A Coppock, **Forrest W. Crawford**, and DP Green. “Combining list experiment and direct question estimates of sensitive behavior prevalence.” *Journal of Survey Statistics and Methodology* **3**, 43–66 (2015).
- [30] **Forrest W. Crawford**, RE Weiss, and MA Suchard. “Sex, lies, and self-reported counts: Bayesian mixture models for longitudinal heaped count data via birth-death processes.” *Annals of Applied Statistics* **9**, 572–596 (2015).
- [31] I Quintero, P Keil, W Jetz, and **Forrest W. Crawford**. “Historical Biogeography Using Species Geographical Ranges.” *Systematic Biology* **64**, 1059–1073 (2015).
- [32] PM Aronow and **Forrest W. Crawford**. “Nonparametric identification for respondent-driven sampling.” *Statistics and Probability Letters* **106**, 100–102 (2015).
- [33] **Forrest W. Crawford** and D Zelterman. “Markov counting models for correlated binary responses.” *Biostatistics* **3**, 427–440 (2015).
- [34] WH Mulder and **Forrest W. Crawford**. “On the distribution of interspecies correlation for Markov mutation models on Yule trees.” *Journal of Theoretical Biology* **364**, 275 – 283 (2015).
- [35] ES Braun, **Forrest W. Crawford**, MM Desai, J Meek, PD Kirley, L Miller, EJ Anderson, O Oni, P Ryan, R Lynfield, M Bargsten, NM Bennett, KL Lung, A Thomas, E Mermel, M Lindegren, W Schaffner, A Price, and SS Chaves. “Obesity not associated with severity among hospitalized adults with seasonal influenza virus infection.” *Infection* pp. 1–7 (2015).
- [36] **Forrest W. Crawford**, VN Minin, and MA Suchard. “Estimation for General Birth-Death Processes.” *Journal of the American Statistical Association* **109**, 730–747 (2014).
- [37] **Forrest W. Crawford** and MA Suchard. “Diversity, disparity, and evolutionary rate estimation for unresolved Yule trees.” *Systematic Biology* **62**, 439–455 (2013).
- [38] OG Pybus, MA Suchard, P Lemey, F Bernadin, A Rambaut, **Forrest W. Crawford**, RR Gray, N Arinaminpathy, S Stramer, MP Busch, and E Delwart. “Unifying the spatial epidemiology and evolution of emerging epidemics.” *Proceedings of the National Academy of Sciences USA* **109**, 15066–15071 (2012).
- [39] **Forrest W. Crawford** and MA Suchard. “Transition probabilities for general birth-death processes with applications in ecology, genetics, and evolution.” *Journal of Mathematical Biology* **65**, 553–580 (2012).
- [40] S Saraswathy, **Forrest W. Crawford**, KL Lamborn, A Pirzkall, S Chang, S Cha, and SJ Nelson. “Evaluation of MR markers that predict survival in patients with newly diagnosed GBM prior to adjuvant therapy.” *Journal of Neuro-Oncology* **91**, 69–81 (2008).
- [41] **Forrest W. Crawford**, IS Khayal, C McGue, S Saraswathy, A Pirzkall, S Cha, KR Lamborn, S Chang, MS Berger, and SJ Nelson. “Relationship of pre-surgery metabolic and physiological MR imaging parameters to survival for patients with untreated GBM.” *Journal of Neuro-Oncology* **91**, 337–351 (2008).
- [42] IS Khayal, **Forrest W. Crawford**, S Saraswathy, KR Lamborn, SM Chang, S Cha, TR McKnight, and SJ Nelson. “Relationship between choline and apparent diffusion coefficient in patients with

- gliomas.” *Journal of Magnetic Resonance Imaging* **27**, 718–725 (2008).
- [43] JC Crane, **Forrest W. Crawford**, and SJ Nelson. “Grid enabled magnetic resonance scanners for near real-time medical image processing.” *Journal of Parallel and Distributed Computing* **66**, 1524–1533 (2006).
- [44] S Cha, T Tihan, **Forrest W. Crawford**, NJ Fischbein, S Chang, A Bollen, SJ Nelson, M Prados, MS Berger, and WP Dillon. “Differentiation of low-grade oligodendrogliomas from low-grade astrocytomas by using quantitative blood-volume measurements derived from dynamic susceptibility contrast-enhanced MR imaging.” *American Journal of Neuroradiology* **26**, 266–273 (2005).
- [45] X Li, DB Vigneron, S Cha, EE Graves, **Forrest W. Crawford**, SM Chang, and SJ Nelson. “Relationship of MR-derived lactate, mobile lipids, and relative blood volume for gliomas in vivo.” *American Journal of Neuroradiology* **26**, 760–769 (2005).

## Submitted Manuscripts

- [1] H Shirado, **Forrest W. Crawford**, and N A Christakis. “Collective and Individual Behavior in Response to Disasters in Online Experiments.” *Submitted* (2019).
- [2] O Morozova, R E Booth, S Dvoriak, K Dumchev, Y Sazonova, T Salyuk, and **Forrest W. Crawford**. “Divergent estimates of HIV incidence among people who inject drugs in Ukraine.” *Submitted* (2018).
- [3] O Morozova, **Forrest W. Crawford**, T Cohen, A D Paltiel, and F L Altice. “Cost-effectiveness of expanding the capacity of opioid agonist treatment in Ukraine: dynamic modeling analysis.” *Submitted* (2018).
- [4] D J Eck, O Morozova, and **Forrest W. Crawford**. “Randomization for the direct effect of an infectious disease intervention in a clustered study population.” *Submitted* (2018).
- [5] L Orr, F Shebl, R Heimer, K Khoshnood, R Barbour, D Khouri, E Aaraj, and **Forrest W. Crawford**. “Violence and discrimination against men who have sex with men in Lebanon.” *Submitted* (2018).
- [6] S Cheng, D J Eck, and **Forrest W. Crawford**. “Estimating the size of a hidden finite set: asymptotic behavior of estimators.” *Submitted* (2018).
- [7] L Zeng, J Li, and **Forrest W. Crawford**. “Estimating recruitment bias in respondent-driven sampling, with application to a network study of injection drug users in Hartford, CT.” *Submitted* (2018).
- [8] S Li, **Forrest W. Crawford**, and M Gerstein. “SigLASSO: a LASSO approach jointly optimizing sampling likelihood and cancer mutation signatures.” *Submitted* (2018).

## Working Papers

- [1] **Forrest W. Crawford**, O Morozova, A L Buchanan, and D Spiegelman. “On the interpretation of the individual effect under treatment spillover.” *Working Paper* (2018).
- [2] S Peng and **Forrest W. Crawford**. “Partial identification and credible estimation for stochastic epidemics with missing data.” *Working Paper* (2018).
- [3] W W Loh and **Forrest W. Crawford**. “Nonparametric identification of causal intervention effects under contagion.” *Working Paper* (2018).
- [4] **Forrest W. Crawford**, F M Marx, J Zelner, M Murray, and T Cohen. “Estimating community and household forces of tuberculosis infection from a household-based study: a transmission modeling analysis.” *Working Paper* (2018).

## Presentations

- 2019 Journées de Statistique, Nancy, France  
Invited Session, Eastern North American Region Spring Meeting, International Biometric Society  
Seminar, Microsoft Research, Redmond, WA  
Seminar, University of North Carolina
- 2018 Seminar, Department of Statistical Sciences, University of Toronto  
Center for Interdisciplinary Research on AIDS  
Career panel, New England Statistical Society NextGen Data Science Day  
Seminar, Ohio State University College of Public Health  
Seminar, Yale HIV Research Club  
Seminar, Health Policy & Management, Yale School of Public Health  
Joint Statistical Meetings, Vancouver, BC  
Network Causal Inference and Design of Experiments Satellite, NetSci, Paris  
Webinar, European Monitoring Centre for Drugs and Drug Addiction  
Seminar, Department of Biostatistics, University of Washington  
WHO Blueprint Plan of Action workshop, Harvard T. H. Chan School of Public Health  
Seminar, Department of Biostatistics, Harvard T. H. Chan School of Public Health  
Seminar, Department of Politics, New York University  
Seminar, Department of Biostatistics and Epidemiology, University of Massachusetts Amherst
- 2017 Seminar, Yale Institute for Network Science  
Seminar, Departments of Biostatistics and Epidemiology, Harvard T. H. Chan School of Public Health  
Seminar, Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health  
Joint Statistical Meetings, Baltimore, MD  
SIMID Workshop, Antwerp, Belgium  
Seminar, Department of Statistics, North Carolina State University  
New England Statistics Symposium, Storrs, CT  
Seminar, Veteran's Affairs Healthcare System, West Haven, CT  
Seminar, Department of Statistics, Simon Fraser University, BC, Canada  
New England HIV Implementation Science Network symposium, Providence, RI  
Seminar, Department of Statistics, Harvard University
- 2016 International Chinese Statistical Association, Shanghai, China  
Seminar, Shanghai Jiao Tong University, Shanghai, China  
Seminar, Network Science Institute, Northeastern University, Boston, MA  
Networks in Public Health Workshop, Center for Interdisciplinary Research on AIDS, Yale  
Discussant, Theory of Agnostic Statistics, Yale  
Joint Statistical Meetings, Chicago, IL  
International Biometric Conference, Victoria, BC, Canada  
Political Networks, Washington University, St. Louis, MO  
Atlantic Causal Inference Conference, New York, NY  
Causal Inference with Highly Dependent Data in Communicable Diseases Research, Harvard  
Workshop on Incomplete Network Data, Sandia National Labs, Livermore, CA  
Center for Communicable Disease Dynamics at the Harvard T.H. Chan School of Public Health  
Center for Research on Inequalities and the Life Course, Yale  
Operations Department, Yale School of Management
- 2015 Seminar, Biostatistics, Brown University School of Public Health, Providence, RI  
Seminar, Biostatistics and Biomathematics, Fred Hutchinson Cancer Research Center, Seattle, WA  
Yale Day of Data

- Seminar, Department of Statistics, University of Wisconsin, Madison, WI  
 Invited talk, FUSION, Washington, DC  
 Computational Social Science Summit, Chicago, IL  
 Invited talk, Statistical Society of Canada Meeting, Halifax, NS  
 Invited talk, New England Statistics Symposium, Storrs, CT  
 Public Health Modeling Seminar; Yale, New Haven CT
- 2014 Yale Institute for Network Science; Yale, New Haven CT  
 Center for Interdisciplinary Research on AIDS, Yale  
 Joint Statistical Meetings, Boston, MA  
 UNAIDS workshop on population size estimation, University of Massachusetts Amherst, Amherst, MA  
 Invited panelist, career development session, New England Statistics Symposium; Boston, MA  
 INSNA Sunbelt Conference, St. Petersburg, FL  
 Invited talk, INFORMS Optimization Society Conference; Rice University, Houston, TX  
 Seminar, Public Health Modeling Seminar; Yale, New Haven CT  
 Seminar, MacMillan Center for the Study of American Politics Workshop on Quantitative Research Methods; Yale University, New Haven, CT
- 2013 Seminar, Department of Biostatistics; Harvard School of Public Health, Boston, MA  
 Seminar, Department of Statistics; University of Connecticut, Storrs, CT  
 Contributed Talk, Joint Statistical Meetings; Montréal, Canada  
 Institute of Mathematical Statistics New Researchers Conference; Montréal, Canada  
 Invited talk, New England Statistics Symposium; Storrs, CT  
 Seminar, Ecology and Evolutionary Biology Department, Yale; New Haven CT
- 2012 Contributed talk, SuStaIn workshop; Bristol, UK  
 Contributed talk, Joint Statistical Meetings; San Diego, CA  
 Poster, International Society for Bayesian Analysis; Kyoto, Japan  
 Seminar, Carnegie Mellon Statistics; Pittsburgh, PA  
 Seminar, Yale Biostatistics; New Haven, CT
- 2011 Case Studies in Bayesian Statistics and Machine Learning; Pittsburgh, PA
- 2010-2012 Systems and Integrative Biology Retreat; Los Angeles, CA
- 2006 International Society for Magnetic Resonance in Medicine Scientific Meeting; Seattle, WA
- 2004 International Society for Magnetic Resonance in Medicine Scientific Meeting; Kyoto, Japan  
 American Society for Neuroradiology Scientific Meeting; Seattle, WA  
 Advances in Imaging Research Symposium; San Francisco, CA

## Awards & Recognition

- 2017 WNAR outstanding written paper award for “Exposure, hazard, and survival analysis of diffusion on social networks ”
- 2016 NIH Director’s New Innovator Award
- 2014 Yale Center for Clinical Investigation Scholar Award
- 2012 Travel Award, SuStaIn workshop
- 2012 Travel Award, International Society for Bayesian Analysis
- 2012 Travel Award, Statistical Analysis of Neural Data
- 2011 Young Researcher presentation, Case Studies in Bayesian Statistics and Machine Learning
- 2011 Travel Award, Case Studies in Bayesian Statistics and Machine Learning
- 2011 Travel Award, Summer Institute in Statistics and Modeling Infectious Disease

2010 Travel Award, Bayesian Nonparametric Statistical Methods  
2011-2012 Regents Fellowship  
2010-2011 University Fellowship  
2008-2012 NIH Systems and Integrative Biology Training Grant

## Professional activities

### **Associate Editor:**

2017- Journal of the American Statistical Association (Theory & Methods)  
2016- Annals of Applied Statistics  
2013-2016 Statistics and Probability Letters

**Reviewer:** American Journal of Epidemiology, Annals of Applied Statistics, Annals of Statistics, Australian & New Zealand Journal of Statistics, Biometrics, BMC Public Health, Clinical Infectious Diseases, Computational Statistics and Data Analysis, Electronic Journal of Statistics, International Journal of Drug Policy, Journal of the American Statistical Association, Journal of Official Statistics, Journal of Molecular Evolution, Journal of Theoretical Biology, Journal of the Royal Society Interface, Journal of the Royal Statistical Society, Journal of Survey Statistics and Methodology, Journal of Urban Health, Medical Decision Making, PloS One, Proceedings of the National Academy of Sciences, Sociological Methodology, Statistical Science, Statistical Methods in Medical Research, Statistics and Probability Letters, Statistics in Medicine, Survey Methodology

**Member:** American Statistical Association, Institute of Mathematical Statistics, International Biometric Society

## Mentoring

Postdoc: Yushuf Sharker, FDA

PhD advisee: Xiaoxuan Cai, Biostatistics

PhD advisee: Margret Erlendsdottir, Biostatistics

MS advisee: Si Cheng, Biostatistics

PhD committee: Julian Zhou, Computational Biology & Bioinformatics

PhD committee: Hirokazu Shirado, Sociology

PhD committee: Kristina Yim, Genetics

PhD qualifying committee: Olga Morozova, Epidemiology of Microbial Diseases

PhD committee: Joe Lewnard, Epidemiology of Microbial Diseases

PhD qualifying committee: Shantao Li, Computational Biology and Bioinformatics

PhD qualifying committee: Yiming Hu, Biostatistics

PhD qualifying committee: Marina Antillon, Epidemiology of Microbial Diseases

MS academic advisee: Yunwei Wang, Biostatistics

PhD qualifying committee: Alexander Bazazi, Epidemiology of Microbial Diseases

PhD qualifying committee: Gregg Gonsalves, Epidemiology of Microbial Diseases

Rotation student: Ignacio Quintero, Ecology and Evolutionary Biology

PhD academic advisee: Briana Cameron, Biostatistics

MS academic advisee: Wei Jiang, Biostatistics

MS academic advisee: Xiaotian Wu, Biostatistics

PhD dissertation committee: Ken Hui, Computational Biology and Bioinformatics

MPH student: Elise Braun Biostatistics

International AIDS trainee: Aleksandr Sirotkin

MS Advisee in bioinformatics: Sarah Elfenbein (joint with Jun Lu)  
Thesis Committee: John Millet, MD. (Radiology)  
Rotation student: Shantao Li, Molecular Biology and Biophysics  
PhD dissertation committee: Xiu Huang, Computational Biology and Bioinformatics

## Service

2018 YSPH Diversity Committee  
2017-2018 Co-Director (with Virginia E. Pitzer), YSPH Modeling Concentration  
2013 CBB Admissions committee  
2012-2014 Department of Biostatistics seminar chair

## Teaching

2013- BIS 557A Computational Statistics, Yale School of Public Health  
2016 BIS 600 Advanced Causal and Network Statistics, Yale School of Public Health (with Peter Aronow)  
2013 FSCI 6302 Population genetics, University of West Indies Mona, Jamaica