Dr SWAPNIL MISHRA

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Research Profile

My current research focuses on developing flexible and scalable models for understanding various spatiotemporal data, for example, epidemics (COVID-19, Malaria, HIV), crime and social media. My work focuses on algorithms to model point processes with classical machine learning techniques as well as using modern deep learning networks, mainly recurrent networks. I have led and produced high impact work (published in journals such as Nature, Science, and the Lancet) that has garnered 7.4k+ citations. My career H-Index is 23 and I10 index is 29. . I have led development and conceptualization of few of the most used models for understanding effectiveness of NPIs and role of variants during the current SARS-CoV2 epidemic. Models available at https://github.com/ImperialCollegeLondon/covid19model, https://github.com/mrc-ide/sarscov2-b.1.1.7, https://github.com/CADDE-CENTRE/Novel-SARS-CoV-2-P1-Lineage-in-Brazil and https://imperialcollegelondon.github.io/covid19local/

Education, Academic and Teaching

Education

2015 – 2019 PhD **Australian National University** – Computational Social Science, Research School of Computer Science
> *Thesis title: Linking Models for Collective Attention in Social Media.*

2012 – 2014 MSc **Australian National University** – Machine Learning, Research School of Computer Science
> *Thesis title: Implementation and Experiments with Novel Parallel and Bursty Non-parametric Topic Models*

2005 – 2009 BEng **University of Pune** - Computer Engineering, Department of Computer Engineering

Academic Positions

2021 - Present   **University of Copenhagen – Postdoctoral researcher in Geostatistics**
2019 - 2021   **Imperial College London – Postdoctoral researcher in Geostatistics**
2015 - 2019   **Australian National University – Research Assistant:** Computational Media Lab
2014 - 2015   **Data61 (CSIRO) – Research Assistant:** *Optimisation research Group*
2012 - 2014   **Australian National University/Data61(NICTA) – Research Assistant:** *Machine learning research Group*

Teaching and Supervision Experience

2021 - present   **PhD secondary supervisor** (Iwona Hawryluk)
2019 - present   **PhD secondary supervisor** (Helen Coupland)
2020 - 2020   **MSc secondary supervisor** (Yiyong Luo)
2020 - 2020   **MSc secondary supervisor** (Tom Keane)
2019 - 2020   **Undergraduate Summer Project secondary supervisor** (Avish Vijayraghavan)
2018 – 2019   **Australian National University –** Co-lecturer, Introduction to Data Management, Analysis and Security
2017 – 2018   **Australian National University –** Co-lecturer, Introduction to Programming for Data Scientists
2013 – 2018   **Australian National University –** Head Teaching Assistant, Document Analysis
2013 – 2014   **Australian National University –** Head Teaching Assistant, Introduction to Programming for Scientists
2008 – 2011   **University of Pune-** Head Teaching Assistant, Robotics

Grants

2020   **Imperial COVID-19 Response Fund (£46,975)** (Co-I)
2020   **Microsoft AI for Health program ($130,000)** (Co-I)
2018   **Amazon AWS Compute Grant ($45,000)** (Co-I)

Consulting

2020   **New York State:** Advisory group for COVID-19 response
2020   **Herbert Smith Freehils:** Advisory group for COVID-19 response

Selected Invited/Keynote speaker Presentations

2020   Keynote lecture: Scalable Mechanistic Bayesian Models for COVID-19 Transmissions, Stan-Con 2020
2020   Invited lecture: Estimating the number of infections and the impact of non-pharmaceutical interventions on COVID-19, European Consortium of Mathematics in Industry
2020   Invited lecture: Estimating the number of infections and R(t) for COVID-19 with a Semi-mechanistic Hierarchical Bayesian Model, DeepMind
2019.   Invited lecture: VAE to learn functions, RSS 2019, Belfast
2019   Invited lecture: Linking Models of Popularity in Social Media, Monash University

2021	The Queen's Anniversary Prize
2018	ICWSM Student Travel Award
2018	ANU Vice Chancellor Travel Grant
2018	ANU Domestic PhD scholarship
2016	CIKM Vice Chancellor Travel Grant
2015	Australia International Student PhD scholarship
2014	KDD Travel Grant
2012	ABU Robocon Misumi Sponsors Award (Team India)
2012	ABU Robocon Mabuchi Motor Award (Team India)

Publication Summary

Total number of peer-reviewed publications: 30

Conference publications: 5

Citation information: 7,700+ Citations

H-index: 23

I10-Index: 29

4 Papers published in Nature (2 first author),

4 Papers published in Science (1 first author, 1 senior author),

4 Paper in Nature Communications (1 first author, 1 senior author),

1 paper in Proceedings of The Royal Society A

1 Paper in the Lancet

Selected Publications

Dhar, M. S., Marwal, R., Radhakrishnan, V. S., Ponnusamy, K., Jolly, B., Bhoyar, R. C., . . . Rakshit, P. (2021). Genomic characterization and epidemiology of an emerging SARS-CoV-2 variant in Delhi, India. *SCIENCE*, *374*(6570), 995-+. doi:10.1126/science.abj9932

Sharma, M., Mindermann, S., Rogers-Smith, C., Leech, G., Snodin, B., Ahuja, J., . . ., Mishra, S., Bhatt, S., Brauner, J. M. (2021). Understanding the effectiveness of government interventions against the resurgence of COVID-19 in Europe. *NATURE COMMUNICATIONS*, *12*(1), 13 pages. doi:10.1038/s41467-021-26013-4

Mlcochova, P., Kemp, S. A., Dhar, M. S., Papa, G., Meng, B., Ferreira, I. A. T. M., . . . Gupta, R. K. (2021). SARS-CoV-2 B.1.617.2 Delta variant replication and immune evasion. *NATURE*, *599*(7883), 114-+. doi:10.1038/s41586-021-03944-y

Mishra, S., Mindermann, S., Sharma, M., Whittaker, C., Mellan, T. A., Wilton, T., . . . Flaxman, S. (2021). Changing composition of SARS-CoV-2 lineages and rise of Delta variant in England. *ECLINICALMEDICINE*, *39*, 8 pages. doi:10.1016/j.eclinm.2021.101064

Mishra, S., Scott, J. A., Laydon, D. J., Flaxman, S., Gandy, A., Mellan, T. A., . . . Bhatt, S. (2021). Comparing the responses of the UK, Sweden and Denmark to COVID-19 using counterfactual modelling. *SCIENTIFIC REPORTS*, *11*(1), 9 pages. doi:10.1038/s41598-021-95699-9

Mohler, G., Mishra, S., Ray, B., Magee, L., Huynh, P., Canada, M., . . . Flaxman, S. (2021). A modified two-process Knox test for investigating the relationship between law enforcement opioid seizures and overdoses. *PROCEEDINGS OF THE ROYAL SOCIETY A-MATHEMATICAL PHYSICAL AND ENGINEERING SCIENCES*, *477*(2250), 13 pages. doi:10.1098/rspa.2021.0195

Bertozzi-Villa, A., Bever, C. A., Koenker, H., Weiss, D. J., Vargas-Ruiz, C., Nandi, A. K., . . . Bhatt, S. (2021). Maps and metrics of insecticide-treated net access, use, and nets-per-capita in Africa from 2000-2020. *NATURE COMMUNICATIONS*, *12*(1), 12 pages. doi:10.1038/s41467-021-23707-7

Faria, N. R., Mellan, T. A., Whittaker, C., Claro, I. M., Candido, D. D. S., Mishra, S., . . . Sabino, E. C. (2021). Genomics and epidemiology of the P.1 SARS-CoV-2 lineage in Manaus, Brazil. *SCIENCE*, *372*(6544), 815-+. doi:10.1126/science.abh2644

Unwin, H. J. T., Routledge, I., Flaxman, S., Rizoiu, M. -A., Lai, S., Cohen, J., . . ., Mishra, S., Bhatt, S. (2021). Using Hawkes Processes to model imported and local malaria cases in near-elimination settings. *PLOS COMPUTATIONAL BIOLOGY*, *17*(4), 18 pages. doi:10.1371/journal.pcbi.1008830

Monod, M., Blenkinsop, A., Xi, X., Hebert, D., Bershan, S., Tietze, S., . . . Mishra, S., Flaxman, S., Bhatt, S., Ratmann, O. (2021). Age groups that sustain resurging COVID-19 epidemics in the United States. *SCIENCE*, *371*(6536), 1336-+. doi:10.1126/science.abe8372

Volz, E., Mishra, S., Chand, M., Barrett, J. C., Johnson, R., Geidelberg, L., . . . Ferguson, N. M. (2021). Assessing transmissibility of SARS-CoV-2 lineage B.1.1.7 in England. *NATURE*, *593*(7858), 266-+. doi:10.1038/s41586-021-03470-x

Laydon, D. J., Mishra, S., Hinsley, W. R., Samartsidis, P., Flaxman, S., Gandy, A., . . . Bhatt, S. (2021). Modelling the impact of the tier system on SARS-CoV-2 transmission in the UK between the first and second national lockdowns. *BMJ OPEN*, *11*(4), 6 pages. doi:10.1136/bmjopen-2021-050346

Unwin, H. J. T., Mishra, S., Bradley, V. C., Gandy, A., Mellan, T. A., Coupland, H., . . . Flaxman, S. (2020). State-level tracking of COVID-19 in the United States. *NATURE COMMUNICATIONS*, *11*(1), 9 pages. doi:10.1038/s41467-020-19652-6

Mishra, S., Scott, J., Zhu, H., Ferguson, N., Bhatt, S., Flaxman, S., & Gandy, A. (2020). A COVID-19 Model for Local Authorities of the United Kingdom. doi:10.1101/2020.11.24.20236661

Hawryluk, I., Mellan, T. A., Hoeltgebaum, H., Mishra, S., Schnekenberg, R. P., Whittaker, C., . . . Bhatt, S. (2020). Inference of COVID-19 epidemiological distributions from Brazilian hospital data. *JOURNAL OF THE ROYAL SOCIETY INTERFACE*, *17*(172), 16 pages. doi:10.1098/rsif.2020.0596

Candido, D. S., Claro, I. M., de Jesus, J. G., Souza, W. M., Moreira, F. R. R., Dellicour, S., . . . Faria, N. R. (2020). Evolution and epidemic spread of SARS-CoV-2 in Brazil. *SCIENCE*, *369*(6508), 1255-+. doi:10.1126/science.abd2161

Lavezzo, E., Franchin, E., Ciavarella, C., Cuomo-Dannenburg, G., Barzon, L., Del Vecchio, C., . . . Crisanti, A. (2021). Suppression of a SARS-CoV-2 outbreak in the Italian municipality of Vo' (vol 584, pg 425, 2020). *NATURE*, 1 page. doi:10.1038/s41586-020-2956-7

Okell, L. C., Verity, R., Watson, O. J., Mishra, S., Walker, P., Whittaker, C., . . . Bhatt, S. (2020). Have deaths from COVID-19 in Europe plateaued due to herd immunity?. *LANCET*, *395*(10241), E110-E111. doi:10.1016/S0140-6736(20)31357-X

Walker, P. G. T., Whittaker, C., Watson, O. J., Baguelin, M., Winskill, P., Hamlet, A., . . . Ghani, A. C. (2020). The impact of COVID-19 and strategies for mitigation and suppression in low- and middle-income countries. *SCIENCE*, *369*(6502), 413-+. doi:10.1126/science.abc0035

Flaxman, S., Mishra, S., Gandy, A., Unwin, H. J. T., Mellan, T. A., Coupland, H., . . . Bhatt, S. (2020). Estimating the effects of non-pharmaceutical interventions on COVID-19 in Europe. *NATURE*, *584*(7820), 257-+. doi:10.1038/s41586-020-2405-7

Mellan, T., Hoeltgebaum, H., Mishra, S., Whittaker, C., Schnekenberg, R., Gandy, A., . . . Bhatt, S. (2020). *Report 21: Estimating COVID-19 cases and reproduction number in Brazil*. doi:10.25561/78872

Vollmer, M., Mishra, S., Unwin, H., Gandy, A., Melan, T., Bradley, V., . . . Bhatt, S. (2020). *Report 20: A sub-national analysis of the rate of transmission of Covid-19 in Italy*. doi:10.25561/78677

Mishra, S. (2019). Bridging Models for Popularity Prediction on Social Media. In *PROCEEDINGS OF THE TWELFTH ACM INTERNATIONAL CONFERENCE ON WEB SEARCH AND DATA MINING (WSDM'19)* (pp. 810-811). Melbourne, AUSTRALIA: ASSOC COMPUTING MACHINERY. doi:10.1145/3289600.3291598

Rizoiu, M. -A., Mishra, S., Kong, Q., Carman, M., & Xie, L. (2018). SIR-Hawkes: Linking Epidemic Models and Hawkes Processes to Model Diffusions in Finite Populations. In *WEB CONFERENCE 2018: PROCEEDINGS OF THE WORLD WIDE WEB CONFERENCE (WWW2018)* (pp. 419-428). Lyon, FRANCE: ASSOC COMPUTING MACHINERY. doi:10.1145/3178876.3186108

Rizoiu, M. -A., Lee, Y., & Mishra, S. (2017). Hawkes processes for events in social media. In *Frontiers of Multimedia Research* (pp. 191-218). ACM. doi:10.1145/3122865.3122874

Mishra, S., Rizoiu, M. -A., & Xie, L. (2016). Feature Driven and Point Process Approaches for Popularity Prediction. In *CIKM'16: PROCEEDINGS OF THE 2016 ACM CONFERENCE ON INFORMATION AND KNOWLEDGE MANAGEMENT* (pp. 1069-1078). IUPUI, Indianapolis, IN: ASSOC COMPUTING MACHINERY. doi:10.1145/2983323.2983812

Buntine, W. L., & Mishra, S. (2014). Experiments with Non-parametric Topic Models. In *PROCEEDINGS OF THE 20TH ACM SIGKDD INTERNATIONAL CONFERENCE ON KNOWLEDGE DISCOVERY AND DATA MINING (KDD'14)* (pp. 881-890). New York, NY: ASSOC COMPUTING MACHINERY. doi:10.1145/2623330.2623691

Rizoiu, M. -A., Lee, Y., Mishra, S., & Xie, L. (n.d.). A Tutorial on Hawkes Processes for Events in Social Media. Retrieved from http://arxiv.org/abs/1708.06401v2

Mishra, S., Rizoiu, M. -A., & Xie, L. (n.d.). Modeling Popularity in Asynchronous Social Media Streams with Recurrent Neural Networks. *Proceedings of the International AAAI Conference on Web and Social Media, 12(1).* Retrieved from https://ojs.aaai.org/index.php/ICWSM/article/view/15030

Hawryluk, I., Hoeltgebaum, H., Mishra, S., Miscouridou, X., Schnekenberg, R. P., Whittaker, C., . . . Mellan, T. A. (n.d.). Gaussian Process Nowcasting: Application to COVID-19 Mortality Reporting. Retrieved from http://arxiv.org/abs/2102.11249v2

Bhatt, S., Ferguson, N., Flaxman, S., Gandy, A., Mishra, S., & Scott, J. A. (n.d.). Semi-Mechanistic Bayesian Modeling of COVID-19 with Renewal Processes. Retrieved from http://arxiv.org/abs/2012.00394v2

Further Publications

Brizzi, A., Whittaker, C., Servo, L. M. S., Hawryluk, I., Prete, C. A., de Souza, W. M., . . . Ratmann, O. (2021). Report 46: Factors driving extensive spatial and temporal fluctuations in COVID-19 fatality rates in Brazilian hospitals.. *medRxiv*. doi:10.1101/2021.11.01.21265731

Purkayastha, S., Bhattacharyya, R., Bhaduri, R., Kundu, R., Gu, X., Salvatore, M., . . ., Mishra, S., Mukherjee, B. (2021). A comparison of five epidemiological models for transmission of SARS-CoV-2 in India. *BMC INFECTIOUS DISEASES*, *21*(1), 23 pages. doi:10.1186/s12879-021-06077-9

Krawczyk, K., Chelkowski, T., Laydon, D. J., Mishra, S., Xifara, D., Flaxman, S., . . . Bhatt, S. (2021). Quantifying Online News Media Coverage of the COVID-19 Pandemic: Text Mining Study and Resource. *JOURNAL OF MEDICAL INTERNET RESEARCH*, *23*(6), 15 pages. doi:10.2196/28253

Mishra, S., Mindermann, S., Sharma, M., Whittaker, C., Mellan, T., Wilton, T., . . . Flaxman, S. (2021). *Report 44: Recent trends in SARS-CoV-2 variants of concern in England: Report 44: Recent trends in SARS-CoV-2 variants of concern in England* (44). Imperial College London. doi:10.25561/88876

Watson, O. J., Alhaffar, M., Mehchy, Z., Whittaker, C., Akil, Z., Brazeau, N. F., . . . Walker, P. (2021). Leveraging community mortality indicators to infer COVID-19 mortality and transmission dynamics in Damascus, Syria. *NATURE COMMUNICATIONS*, *12*(1), 10 pages. doi:10.1038/s41467-021-22474-9

Ragonnet-Cronin, M., Boyd, O., Geidelberg, L., Jorgensen, D., Nascimento, F. F., Siveroni, I., . . . Volz, E. (2021). Genetic evidence for the association between COVID-19 epidemic severity and timing of non-pharmaceutical interventions. *NATURE COMMUNICATIONS*, *12*(1), 7 pages. doi:10.1038/s41467-021-22366-y

Vollmer, M. A. C., Glampson, B., Mellan, T., Mishra, S., Mercuri, L., Costello, C., . . . Bhatt, S. (2021). A unified machine learning approach to time series forecasting applied to demand at emergency departments. *BMC EMERGENCY MEDICINE*, *21*(1), 14 pages. doi:10.1186/s12873-020-00395-y

Fu, H., Wang, H., Xi, X., Boonyasiri, A., Wang, Y., Hinsley, W., . . . Ferguson, N. M. (2021). Database of epidemic trends and control measures during the first wave of COVID-19 in mainland China. *INTERNATIONAL JOURNAL OF INFECTIOUS DISEASES*, *102*, 463-471. doi:10.1016/j.ijid.2020.10.075

Meyerowitz-Katz, G., Bhatt, S., Ratmann, O., Brauner, J. M., Flaxman, S., Mishra, S., . . . Yamey, G. (2021). Is the cure really worse than the disease? The health impacts of lockdowns during COVID-19. *BMJ GLOBAL HEALTH*, *6*(8), 6 pages. doi:10.1136/bmjgh-2021-006653

Flaxman, S., Mishra, S., Scott, J., Ferguson, N., Gandy, A., & Bhatt, S. (2020). The effect of interventions on COVID-19 Reply. *NATURE*, *588*(7839), E29-E32. doi:10.1038/s41586-020-3026-x

Thompson, H. A., Imai, N., Dighe, A., Ainslie, K. E. C., Baguelin, M., Bhatia, S., . . . Ferguson, N. M. (2020). SARS-CoV-2 infection prevalence on repatriation flights from Wuhan City, China. *JOURNAL OF TRAVEL MEDICINE*, *27*(8), 3 pages. doi:10.1093/jtm/taaa135

Grassly, N. C., Pons-Salort, M., Parker, E. P. K., White, P. J., & Ferguson, N. M. (2020). Comparison of molecular testing strategies for COVID-19 control: a mathematical modelling study. *LANCET INFECTIOUS DISEASES*, *20*(12), 1381-1389. doi:10.1016/S1473-3099(20)30630-7

Okell, L. C., Verity, R., Katzourakis, A., Volz, E. M., Watson, O. J., Mishra, S., . . . Bhatt, S. (2020). Host or pathogen-related factors in COVID-19 severity? Reply. *LANCET*, *396*(10260), 1397. Retrieved from http://gateway.webofknowledge.com/

Brazeau, N., Verity, R., Jenks, S., Fu, H., Whittaker, C., Winskill, P., . . . Okell, L. (2020). *Report 34: COVID-19 infection fatality ratio: estimates from seroprevalence*. doi:10.25561/83545

Dighe, A., Cattarino, L., Cuomo-Dannenburg, G., Skarp, J., Imai, N., Bhatia, S., . . . Riley, S. (2020). Response to COVID-19 in South Korea and implications for lifting stringent interventions. *BMC MEDICINE*, *18*(1), 12 pages. doi:10.1186/s12916-020-01791-8

Hogan, A. B., Jewell, B. L., Sherrard-Smith, E., Vesga, J. F., Watson, O. J., Whittaker, C., . . . Hallett, T. B. (2020). Potential impact of the COVID-19 pandemic on HIV, tuberculosis, and malaria in low-income and middle-income countries: a modelling study. *LANCET GLOBAL HEALTH*, *8*(9), E1132-E1141. doi:10.1016/S2214-109X(20)30288-6

Jeffrey, B., Walters, C. E., Ainslie, K. E. C., Eales, O., Ciavarella, C., Bhatia, S., . . . Riley, S. (2020). Anonymised and aggregated crowd level mobility data from mobile phones suggests that initial compliance with

covid-19 social distancing interventions was high and geographically consistent across the UK. *Wellcome Open Research*, *5*, 1-10. doi:10.12688/WELLCOMEOPENRES.15997.1

Fu, H., Xi, X., Wang, H., Boonyasiri, A., Wang, Y., Hinsley, W., . . . Ferguson, N. (2020). *Report 30: The COVID-19 epidemic trends and control measures in mainland China*. doi:10.25561/80360

Jeffrey, B., Walters, C., Ainslie, K., Eales, O., Ciavarella, C., Bhatia, S., . . . Riley, S. (2020). *Report 24: Mobility data from mobile phones suggests that initial compliance with COVID-19 social distancing interventions was high and geographically consistent across the UK* (24). doi:10.25561/79387

Winskill, P., Whittaker, C., Walker, P., Watson, O., Laydon, D., Imai, N., . . . Ghani, A. (2020). *Report 22: Equity in response to the COVID-19 pandemic: an assessment of the direct and indirect impacts on disadvantaged and vulnerable populations in low- and lower middle-income countries* (22). doi:10.25561/78965

Grassly, N., Pons Salort, M., Parker, E., White, P., Ainslie, K., Baguelin, M., . . . Ferguson, N. (2020). *Report 16: Role of testing in COVID-19 control*. doi:10.25561/78439

Routledge, I., Lai, S., Battle, K. E., Ghani, A. C., Gomez-Rodriguez, M., Gustafson, K. B., . . . Bhatt, S. (2020). Tracking progress towards malaria elimination in China: Individual-level estimates of transmission and its spatiotemporal variation using a diffusion network approach. *PLOS COMPUTATIONAL BIOLOGY*, *16*(3), 20 pages. doi:10.1371/journal.pcbi.1007707

Scott, J. A., Gandy, A., Mishra, S., Bhatt, S., Flaxman, S., Unwin, H. J. T., & Ish-Horowicz, J. (n.d.). Epidemia: An R Package for Semi-Mechanistic Bayesian Modelling of Infectious Diseases using Point Processes. Retrieved from http://arxiv.org/abs/2110.12461v1