Dr Souvik Barat

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Summary

Souvik Barat is a distinguished Principal Scientist at Tata Consultancy Services Research, India, a Visiting Researcher at Middlesex University London and adjunct faculty at Walchand College of Engineering, Sangli, India. With 27 years of experience in industrial research, his work has contributed to the development of two TCS products - MasterCraft and TCS TwinX. His research interests include Digital Twin technology, modeling and simulation of complex systems, AI, Model Driven Engineering, Software Product Lines, and Business Process Management. Currently, he is actively involved in developing digital twins for complex business and societal systems. His work on digital twins for business systems led to the Best TCS Innovation Award in 2019 and the Gold Stevie Award under the AI/ML category in 2021. His efforts toward modeling cities to systematically return to a new normal without compromising public health safety have been extensively utilized by city-based healthcare organizations and municipal corporations. Earlier, he served as the lead architect of a model-driven toolset that has been used to deliver large IT systems for over a decade and led a research initiative to develop a platform for product line architecture.

Education

1. **Ph.D., Middlesex University, London** in Computer Science.
   Thesis title: Actor based behavioural simulation as an aid for organisational decision making.
2. **M.S. Indian Institute of Technology (IIT), Madras** in Software Engineering.
   Thesis title: A framework for business processes view integration.
3. **B.E. Indian Institute of Engineering Science and Technology (IIEST), Shibpur** in Computer Science & Technology.

Work Experience

1. Distinguished Principal Scientist at Tata Consultancy Services Research, Pune, India

2. Research Head of Enterprise Digital Twin (2014-current): Enterprise Digital Twin is a novel agent-based multi-modelling platform for business and social systems.
3. Visiting Researcher, London Digital Twin Research Centre, Middlesex University London (2021 – current).
4. Research contributor of TCS TwinX — A TCS product for Digital Twins platform.
5. Creator of city digital twin to explore the efficacy of non-pharmaceutical interventions with respect spread of COVID19 - extensively used by Pune (a city of western India) municipality administrators.
6. Co-creator of a model driven engineering platform that has been extensively used TCS business for more than a decade.
7. Publications: Authored 50+ peer reviewed conference papers including two best paper awards at leading European simulation conferences, 8 book chapters, and 3 journal papers.
8. Contribution towards industrial standardization: Actively participated in OMG CVL (Common Variability Language) standardization in 2012-2013.

Awards and Recognitions

Industry Recognitions:

1. EDT based TwinX received Gold Steve award 2021 in the category of Artificial Intelligence/Machine Learning Solution.
2. TCS won CNBC-TV18 India Risk Management Awards (#IRMA2022) for refining BCP using EDT based TCS Covid19 model. CNBC-TV18 India Risk Management Awards (#IRMA2022).

Visiting Researcher and community acceptance:

Inducted as visiting Researcher at Middlesex University to support London Digital Twin Research initiatives.

Best Paper awards:

1. In 31st Annual European Simulation and Modelling conference 2017, ESM 2017 for paper titled "A domain specific language for complex dynamic decision making" by **Barat, S.**, Clark, T., Kulkarni, V., & Barn, B.
2. In The European symposium on modeling and simulation, EMSS 2017 for paper titled "Supporting organisational decision making in presence of uncertainty" by Kulkarni, V., **Barat, S.**, Clark, T., & Barn, B.

TCS Recognitions:

1. Received the TCS Innovista award in 2020.
2. Honored with the Distinguished Scientist award in 2021.

Publications

Journal

1. **Barat, S.,** Paranjape, A., Kulkarni, V., Parchure, R., Darak, S. & Kulkarni, V. **(2022). Understanding emergent dynamism of Covid19 pandemic in a city**. Transactions of the Indian National Academy of Engineering, 1–27.
2. **Barat, S.**, Parchure, R., Darak, S., Kulkarni, V., Paranjape, A., Gajrani, M., Yadav, A., & Kulkarni, V. (2021). An agent-based digital twin for exploring localized non-pharmaceutical interventions to control covid-19 pandemic. Transactions of the Indian National Academy of Engineering, 1–31.
3. **Barat, S.**, Kulkarni, V., & Barn, B. (2018). Towards improved organisational decision-making - A method and tool-chain. Enterprise Model. Inf. Syst. Archit. Int. J. Concept. Model., 13, 6:1–6:16.
4. Kulkarni, V., & **Barat, S.** (2011). Business process families using model-driven techniques. Int. J. Bus. Process. Integr. Manag., 5(3), 204–217.

Book Chapters

1. **Barat, S.** (2020). Enterprise digital twin: An approach to construct digital twin for complex enterprises. In Advanced digital architectures for model-driven adaptive enterprises (pp. 68–89). IGI Global.
2. **Barat, S.**, & Rajbhoj, A. (2020). IT systems for the digital enterprise. In Advanced digital architectures for model-driven adaptive enterprises (pp. 113–131). IGI Global.
3. Clark, T., Kulkarni, V., **Barat, S.**, & Barn, B. (2018a). A homogeneous actor-based monitor language for adaptive behaviour. In A. Ricci & P. Haller (Eds.), Programming with actors - state-of-the-art and research perspectives (Vol. 10789, pp. 216–244). Springer.

Conference Publications

1. **Barat, S**., Mulpuru, D., Yadav, A., Korabu, R., Thogaru, H., & Kulkarni, V. (2025). Constructing Enterprise Digital Twins by Augmenting LLMs with MDE. ISEC 2025: 11:1-11:11
2. **Barat, S**., Deshpande, P., Yadav, A., Paranjape, A. A., Kulkarni, V., Rai, B., Vora, H. K., Kumar, S., Pahare, I., Mittal, P., Bansal, M., & Sai, V. (2024). Digital Twin as an Aid for Optimizing Climacteric Fruit Supply Chains. ANNSIM 2024: 1-14
3. Shrivastava, S., **Barat, S**., Kausley, S., Kulkarni, V., & Rai, B. (2024). River Digital Twin for Water Quality Prediction. WSC 2024: 608-619
4. **Barat, S.**, Yadav, A., Thogaru, H., Kulkarni, V., & Bhattacharya, K. (2024). Imparting Adaptiveness and Resilience to Parcel Delivery Networks: A Digital Twin Centric Simulation Based Approach. WSC 2024: 2999-3010
5. Barn, B., Clark, T., **Barat, S.**, & Kulkarni, V. (2023). Towards the Essence of Specifying Sociotechnical Digital Twins. ISEC 2023: 18:1-18:5
6. **Barat, S.**, Kulkarni, V., Clark, T., & Barn, B. S. (2022). Digital twin as risk free experimentation aid for techno-socio-economic systems. In 25th ACM/IEEE international Conference on Model Driven Engineering Languages and Systems, MoDELS 2022, Montreal, Canada, October 23 - October 28, 2022.
7. **Barat, S.**, Kulkarni, V., & Bhattacharya, K. (2022). Enterprise digital twins for risk free business experimentations. In 2022 Winter Simulation Conference, WSC 2022, Singapore, December 11-14, 2022, IEEE.

8. **Barat, S.**, Kulkarni, V., Paranjape, A., Parchure, R., Darak, S., & Kulkarni, V. (2022). Agent based simulatable city digital twin to explore dynamics of covid-19 pandemic. In 2022 Winter Simulation Conference, WSC 2022, Singapore, December 11-14, 2022, IEEE.
9. Paranjape, A., **Barat, S.**, Basu, A., Kulkarni, V., Ghosh, S., & Salvi, R. (2022). Modeling and simulation for the spread of covid-19 in an indian city: A case study. In 2022 Winter Simulation Conference, WSC 2022, Singapore, December 11-14, 2022, IEEE.
10. **Barat, S.**, Mulpuru, D., Yadav, A., Basu, A., Kulkarni, V., Samudrala, S., Bhide, A., Thomas, P., Krishna, K., Yadav, A. & Mazumder, A. (2022). A digital twin based approach for ensuring business continuity plan and safe return to workplace. In Annual Modeling and Simulation conference, San Diego, CA, July 18 - 20, 2022, IEEE.
11. **Barat, S.**, Kulkarni, V., Paranjape, A., Dhandapani, S., Manuelraj, S., & Parameswaran, S. P. (2022). Agent based digital twin of sorting terminal to improve efficiency and resiliency in parcel delivery. In 20th international conference on Practical Applications of Agents and Multi-agent Systems (PAAMS), L'Aquila, Italy, July 13 - 15, 2022.
12. Kulkarni, V., **Barat, S.**, Yadav, A., Mulpuru, D., & Basu, A. (2022). Digital twin assisted decision making. In 20th international conference on Practical Applications of Agents and Multi-agent Systems (PAAMS), L'Aquila, Italy, July 13 -15, 2022.
13. Lobo, S., **Barat, S.**, Korabu, R., Thogaru, H., & Mahamuni, R. (2022). Congruence of service design and simulation. In DMI: Academic design management conference ADMC22, Toronto, Canada, August 3 - 4, 2022.
14. Ghosh, S., Pal, A., Kumar, P., Ojha, A., Paranjape, A., **Barat, S.**, & Khadilkar, H. (2021). A simulation driven optimization algorithm for scheduling sorting center operations. In 2021 Winter Simulation Conference, WSC 2021, Phoenix, AZ, December 13-16, 2021, IEEE.
15. **Barat, S.**, Barn, B., Clark, T., & Kulkarni, V. (2020). OrgML - A domain specific language for organizational decision-making. In The practice of enterprise modeling - 13th IFIP working conference, PoEM 2020, Riga, Latvia, November 25-27, 2020, proceedings (Vol. 400, pp. 155–170).
16. **Barat, S.**, Kulkarni, V., Kumar, P., Bhattacharya, K., Natarajan, S., & Viswanathan, S. (2020). Towards effective design and adaptation of csp using modelling and simulation based digital twin approach. In Proceedings of the 2020 Summer Simulation Conference (pp. 1–12).
17. Clark, T., Barn, B., Kulkarni, V., & **Barat**, S. (2020). Language support for multi agent reinforcement learning. In ISEC 2020: 13th innovations in software engineering conference, Jabalpur, India, February 27-29, 2020 (7:1–7:12).
18. **Barat, S.**, Khadilkar, H., Meisheri, H., Kulkarni, V., Baniwal, V., Kumar, P., & Gajrani, M. (2019). Actor based simulation for closed loop control of supply chain using reinforcement learning. In Proceedings of the 18th international conference on autonomous agents and multiagent systems, AAMAS Montreal, Canada, May 13-17, 2019 (pp. 1802–1804).
19. **Barat, S.**, Kulkarni, V., Clark, T., & Barn, B. (2019). An actor based simulation driven digital twin for analyzing complex business systems. In 2019 Winter Simulation Conference, WSC 2019, National Harbor, MD, USA, December 8-11, 2019 (pp. 157–168).
20. **Barat, S.**, Kumar, P., Gajrani, M., Khadilkar, H., Meisheri, H., Baniwal, V., & Kulkarni, V. (2019). Reinforcement learning of supply chain control policy using closed loop multi-agent simulation. In Multi-agent-based simulation - 20th international workshop, MABS Montreal, Canada, May 13, 2019, revised selected papers (Vol. 12025, pp. 26–38).
21. Clark, T., Barn, B., Kulkarni, V., & **Barat, S.** (2019). Making sense of actor behaviour: An algebraic filmstrip pattern and its implementation. In Proceedings of the 12th innovations on

software engineering conference (formerly known as India software engineering conference), ISEC 2019, Pune, India, February 14-16, 2019 (13:1–13:10).
22. Kulkarni, V., **Barat, S.**, & Clark, T. (2019). Towards adaptive enterprises using digital twins. In 2019 Winter Simulation Conference, WSC 2019, national harbor, MD, USA, December 8-11, 2019 (pp. 60–74).
23. Clark, T., Kulkarni, V., **Barat, S.**, & Barn, B. (2018). Actor-based methods, concepts and tools for analysing emergent behaviour: An introduction to a model based approach. In Proceedings of the 11th Innovations in Software Engineering Conference, ISEC 2018, Hyderabad, India, February 09 - 11, 2018 (21:1–21:2).
24. **Barat, S.**, Clark, T., Kulkarni, V., & Barn, B. (2017). A domain specific language for complex dynamic decision making. In 31st Annual European Simulation and Modelling Conference 2017, ESM 2017 (pp. 135–142). (Best Paper).
25. **Barat, S.** (2017). An actor-based bottom-up simulation aid for complex dynamic decision making. In Trends in cyber-physical multi-agent systems. the PAAMS collection - 15th international conference, Porto, Portugal, June 21-23, 2017, special sessions (Vol. 619, pp. 275–278).
26. **Barat, S.**, Clark, T., Barn, B. S., & Kulkarni, V. (2017). A model-based approach to systematic review of research literature. In Proceedings of the 10th innovations in software engineering conference, ISEC 2017, Jaipur, India, February 5-7, 2017 (pp. 15–25).
27. **Barat, S.**, Kulkarni, V., Clark, T., & Barn, B. (2017a). A method for effective use of enterprise modelling techniques in complex dynamic decision making. In The practice of enterprise modeling - 10th IFIP WG 8.1. working conference, PoEM 2017, Leuven, Belgium, November 22-24, 2017, proceedings (Vol. 305, pp. 319–330).
28. **Barat, S.**, Kulkarni, V., Clark, T., & Barn, B. (2017b). A model based approach for complex dynamic decision-making. In Model-driven engineering and software development - 5th international conference, MODELSWARD 2017, Porto, Portugal, February 19-21, 2017, revised selected papers (Vol. 880, pp. 94–118).
29. **Barat, S.**, Kulkarni, V., Clark, T., & Barn, B. (2017c). A model based realisation of actor model to conceptualise an aid for complex dynamic decision-making. In Proceedings of the 5th international conference on model-driven engineering and software development, MODELSWARD 2017, Porto, Portugal, February 19-21, 2017 (pp. 605–616).
30. **Barat, S.**, Kulkarni, V., Clark, T., & Barn, B. (2017d). An actor-model based bottom-up simulation - an experiment on Indian demonetisation initiative. In 2017 Winter Simulation Conference, WSC 2017, Las Vegas, NV, USA, December 3-6, 2017 (pp. 860–871).
31. Barn, B., **Barat, S.**, & Clark, T. (2017). Conducting systematic literature reviews and systematic mapping studies. In Proceedings of the 10th innovations in software engineering conference, ISEC 2017, Jaipur, India, February 5-7, 2017 (pp. 212–213).
32. Clark, T., Barn, B., Kulkarni, V., & **Barat, S.** (2017). Querying histories of organisation simulations. In Information systems development: Advances in methods, tools and management - proceedings of the 26th international conference on information systems development, ISD 2017, Larnaca, Cyprus, university of central Lancashire Cyprus, September 6-8, 2017.
33. Clark, T., Kulkarni, V., **Barat, S.**, & Barn, B. (2017). Actor monitors for adaptive behaviour. In Proceedings of the 10th innovations in software engineering conference, ISEC 2017, Jaipur, India, February 5-7, 2017 (pp. 85–95).
34. Clark, T., Kulkarni, V., Barat, S., & Barn, B. (2017). ESL: an actor-based platform for developing emergent behaviour organisation simulations. In Advances in practical applications of cyber-

physical multi-agent systems: The PAAMS collection - 15th international conference, Porto, Portugal, June 21-23, 2017, proceedings (Vol. 10349, pp. 311–315).
35. Clark, T., Kulkarni, V., **Barat, S.**, & Barn, B. (2017). Generating filmstrip models from actor-based systems. In Proceedings of MODELS 2017 satellite event: Workshops co-located with 20th international conference on model driven engineering languages and systems (MODELS 2017), Austin, USA, September, 17, 2017 (Vol. 2019, pp. 576–582).
36. Clark, T., Kulkarni, V., Barn, B., & **Barat, S.** (2017). The construction and interrogation of actor based simulation histories. In Proceedings of the ER forum 2017 and the ER 2017 demo track co-located with the 36th international conference on conceptual modelling (ER 2017), Valencia, Spain, November 6-9, 2017 (Vol. 1979, pp. 320–333).
37. Kulkarni, V., **Barat, S.**, Clark, T., & Barn, B. (2017). Supporting organisational decision making in presence of uncertainty. In The European Symposium on Modeling and Simulation, EMSS 2017. (Best Paper).
38. **Barat, S.** (2016). A simulation based aid for complex dynamic decision making. In Proceedings of the doctoral consortium at the 9th IFIP WG 8.1 working conference on the practice of enterprise modeling (PoEM) co-located with the 9th IFIP WG 8.1 working conference on the practice of enterprise modeling (PoEM 2016), Skövde, Sweden, November 8th, 2016 (Vol. 1765, pp. 22–31).
39. **Barat, S.**, Clark, T., Kulkarni, V., & Barn, B. (2016). A conceptual model for organisational decision-making and its possible realisations. In European Simulation and Modelling Conference 2016, ESM 2016 (pp. 174–176).
40. **Barat, S.**, Kulkarni, V., Clark, T., & Barn, B. (2016). A simulation-based aid for organisational decision-making. In Proceedings of the 11th international joint conference on software technologies (ICSOFT 2016) - volume 2: Icsoft-pt, Lisbon, Portugal, July 24 - 26, 2016 (pp. 109–116).
41. **Barat, S.**, Kulkarni, V., Clark, T., & Barn, B. (2016). Enterprise modeling as a decision making aid: A systematic mapping study. In The practice of enterprise modeling - 9th IFIP WG 8.1. working conference, PoEM 2016, Skövde, Sweden, November 8-10, 2016, proceedings (Vol. 267, pp. 289–298).
42. Kulkarni, V., **Barat, S.**, Clark, T., & Barn, B. (2015). Using simulation to address intrinsic complexity in multi-modelling of enterprises for decision making. In Proceedings of the conference on summer computer simulation, Summersim 2015, Chicago, IL, USA, July 26-29, 2015 (9:1–9:11).
43. Kulkarni, V., **Barat, S.**, Clark, T., & Barn, B. S. (2015). Toward overcoming accidental complexity in organizational decision-making. In 18th ACM/IEEE international conference on model driven engineering languages and systems, MoDELS 2015, Ottawa, ON, Canada, September 30 - October 2, 2015 (pp. 368–377).
44. Kulkarni, V., Clark, T., **Barat, S.**, & Barn, B. (2014). Model based enterprise simulation and analysis - A pragmatic approach reducing the burden on experts. In Advances in conceptual modeling - ER 2014 workshops, ENMO, Atlanta, GA, USA, October 27-29, 2014. proceedings (Vol. 8823, pp. 3–12).
45. Kulkarni, V., **Barat, S.**, & Roychoudhury, S. (2012). Towards business application product lines. In Model driven engineering languages and systems - 15th international conference, MODELS 2012, Innsbruck, Austria, September 30-October 5, 2012. proceedings (Vol. 7590, pp. 285–301).
46. **Barat, S.**, & Kulkarni, V. (2011). A component abstraction for business processes. In Business process management workshops - BPM 2011 international workshops, Clermont-Ferrand, France, August 29, 2011, revised selected papers, part II (Vol. 100, pp. 301–313).

47. Kulkarni, V., **Barat, S.**, & Ramteerthkar, U. (2011). Early experience with agile methodology in a model-driven approach. In Model driven engineering languages and systems, 14th international conference, MODELS 2011, Wellington, New Zealand, October 16-21, 2011. proceedings (Vol. 6981, pp. 578–590).
48. **Barat, S.**, & Kulkarni, V. (2010). Developing configurable extensible code generators for model-driven development approach. In Proceedings of the 22nd international conference on software engineering & knowledge engineering (SEKE'2010), Redwood city, San Francisco Bay, CA, USA, July 1 - July 3, 2010 (pp. 577–582).
49. Kulkarni, V., & **Barat, S.** (2010). Business process families using model-driven techniques. In Business process management workshops - BPM 2010 international workshops and education track, Hoboken, NJ, USA, September 13-15, 2010, revised selected papers (Vol. 66, pp. 314–325).
50. **Barat, S.**, & Kulkarni, V. (2008). A model-driven toolset to support an approach for analyzing integration of business process aspect of enterprise application integration. In Proceedings of the twentieth international conference on software engineering & knowledge engineering, San Francisco, CA, USA, July 1-3, 2008 (pp. 625–630).
51. **Barat, S.**, Kulkarni, V., & Janakiram, D. (2006). A safety criterion for reusing a business process in the desired integrated. In 2006 IEEE international conference on services computing (SCC'06) (pp. 381–389). IEEE