KISHOR PATIL

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RESEARCH INTERESTS

Machine Learning, (Deep) Reinforcement Learning, Multi-Arm Restless Bandits, Q-learning, Markov Decision Processes, Stochastic Approximations, Optimisation, Stochastic Modelling, Convergence, Markov Chains.

EDUCATION

Ph.D., Telecommunications and Information Processing, Ghent University	Dec. 2015 - Sept. 2019
M.Tech., Industrial Engineering and Operations Research, IIT Bombay **(GPA: 9.16/10)**	Jul. 2012 - Jun. 2014
B.Tech., Electronics and Telecommunication, SGGSIET Nanded **(GPA: 8.43/10)**	Jul. 2008 - Jun. 2012

RESEARCH EXPERIENCE

Postdoctoral Research Scientist   Oct. 2019 - Present
INRIA, Sophia Antipolis, France
Advisor: Dr. K. Avrachenkov
Machine learning with applications in adaptive web crawling

- Working on dynamic scheduling for adaptive web crawling with (deep) reinforcement learning (RL) using multi-arm restless bandit framework.
- Obtained Whittle indices of restless bandits online through Q-learning and deep learning. Especially for large state space, these indices are learned through a artificial neural network (ANN).
- Developed three novel online algorithms using machine learning (stochastic approximations) which can learn exact dynamics of web page change process. The developed model was tested on large Wikipedia data set and the performance is evaluated through convergence rate and analysis of variance .
- Working on deep RL (Double DQN) models for influence maximisation in dynamic complex networks. The model is being tested on various real data sets (hospital, high-school, meme-tracker, etc).

Provably convergent algorithm for deep reinforcement learning

- Proposed a modified scheme called Full Gradient DQN (FG-DQN) scheme that has a sound theoretical basis and compared it with the original scheme (DQN) on sample problems.
- Establish theoretical convergence guarantees for FG-DQN with stochastic approximations and showed that it gives better performance at the expense of some additional computational overhead per iteration.
- Performed extensive numerical simulations on Open AI gym environment to compare the performance of FGDQN with respect to standard double DQN.

Ph.D. Research   Dec. 2015 - Sep. 2019
Ghent University, Ghent, Belgium
Advisors: Prof. D. Fiems, Dr. K. De Turck
Stochastic modelling of wireless sensor networks

- Obtained optimal control policies for an energy harvesting wireless sensor network using Markov decision processes and analysed the impact of the value of information on the transmission policy of the node.
- Proposed and solved a stochastic model for an energy harvesting wireless sensor node where the energy harvesting process is Markov-modulated and the data sensing process is ergodic. The performance analysis of the model can be used for optimising the design of wireless sensor networks.
- Proposed a numerically tractable stochastic model for the performance evaluation of depth-based routing in underwater wireless sensor networks which requires significantly less computational efforts as compared to standard network simulators.

Optimal control for large scale wireless sensor networks

- Developed a stochastic model for large sensor networks without energy harvesting dynamics, relying on large-scale techniques including a mean field approach, fluid and diffusion limits.
- Investigated how well these models could capture the performance of the sensor networks by comparing numerical experiments with the model with the outcome of simulation experiments.
- Obtained some interesting theoretical proprieties of the optimal transmission policies which are easy to implement in practice, such as a bang-bang nature and a threshold structure.

PUBLICATIONS

- N. Hemachandra, **K. Patil**, and S. Tripathi. Equilibrium points and equilibrium sets of some GI/M/1 queues *Queueing Systems, doi: 10.1007/s11134-020-09677-5.* 2020.

- K. Avrachenkov, **K.Patil** and G. Thoppe. Online Algorithms for Estimating Change Rates of Web Pages, *In VALUETOOLS 2020 - 13th EAI International Conference on Performance Evaluation Methodologies and Tools.* ACM, New York, NY, USA, 3–10.

- **K. Patil** , M. Jafri, D. Fiems and A. Marin. Stochastic Modeling of Depth Based Routing in Underwater Sensor Networks. *Ad Hoc Networks* 1570-8705 (19) : 132-141, 2019.

- **K. Patil**, K. De Turck, and D. Fiems. Optimal data collection in wireless sensor networks with correlated energy harvesting. *Annals of Telecommunication* 1958-9395 : 1-12, 2018.

- **K. Patil**, and D. Fiems. The value of information in energy harvesting sensor networks. *Operations Research Letters* 46 (3) : 362-366, 2018.

- **K. Patil**, K. De Turck, Koen and D. Fiems. A two-queue model for optimising the value of information in energy-harvesting sensor networks. *Performance Evaluation* 0166-5316 (119) : 27-42, 2017.

- **K. Patil**, K. De Turck, and D. Fiems. Optimal Data Collection in Hybrid Energy-harvesting Sensor Networks. *Analytical and Stochastic Modelling Techniques and Applications* 9845:239–252, 2016.

UNDER REVIEW PUBLICATIONS

- K. Avrachenkov, **K.Patil** and G. Thoppe. Online Algorithms for Estimating Change Rates of Web Pages. *Performance evaluation, Submitted* 2020.

- K. Avrachenkov, V. Borkar, H. Dolhare, and **K.Patil**. Full Gradient DQN Reinforcement Learning: A Provably Convergent DQN Scheme. *ACM, Submitted* 2021.

- K. Avrachenkov, H. Dijazi, and **K.Patil**. Deep reinforcement learning for influence maximisation in dynamic networks. *Under Preparation* 2021.

- **K. Patil**, K. De Turck, and D. Fiems. Optimal control in large scale wireless sensor networks - A mean field approach . *Sensor Networks, under preparation,* 2021.

PROCEEDINGS AND REPORTS

- K. Avrachenkov, **K.Patil** and G. Thoppe. Change Rate Estimation and Optimal Freshness in Web Page Crawling, *In VALUETOOLS 2020 - 13th EAI International Conference on Performance Evaluation Methodologies and Tools.* ACM, New York, NY, USA, 3–10.

- **K. Patil**, K. De Turck, and D. Fiems. Optimal Data Collection in Hybrid Energy-harvesting Sensor Networks. *Analytical and Stochastic Modelling Techniques and Applications* 9845:239–252, 2016.

- N. Hemachandra, S. Tripathi, and **K. Patil**. Equilibrium sets of some $GI/M/1$ queues (with more examples). *IIT Bombay* 2016.

SELECTED TALKS

- **K. Patil**, joint work with K. Avrachenkov and G. Thoppe   INRIA, 2020
Online algorithms for estimating page change rates in adaptive web page crawling

- **K. Patil**, joint work with K. De Turck, Koen and D. Fiems   INRIA, 2019
Performance evaluation of large-scale wireless sensor networks - A mean field approach.

- **K. Patil**, joint work with K. De Turck, Koen and D. Fiems   IIT Bombay 2019
Stochastic Modelling of energy harvesting wireless sensor networks

- **K. Patil** joint work with M. Jafri, D. Fiems and A. Marin   StochMod 2018
Performance evaluation of depth based routing in underwater sensor networks

- **K. Patil**, joint work with K. De Turck, Koen and D. Fiems   ECQT 2018
Optimal control in wireless sensor networks: a mean-field approach

TEACHING EXPERIENCE

Ghent University
Teaching Assistant, Department of TELIN, Ghent University

C003399 Computer Intensive Statistical Methods   Spring 2018

IIT Bombay
Teaching Assistant, Department of IEOR, IIT Bombay

- IE 616 Decision Analysis and Game Theory   Spring 2014
- IE 605 Engineering Statistics   Autumn 2013

SKILL SET

Programming Languages	Python (numpy, scipy, pytorch), C, SQL, AMPL
Computational/ Utility Tools	MATLAB, Mathematica, LaTeX
Statistical Tools	R, SAS
Platforms	Mac OS, Linux (Ubuntu, Fedora)

ADDITIONAL TRAINING

Workshops

- Summer school on Numerical methods for stochastic models: mean-field, CIRM, Marseille   summer 2017
- Introduction to High performance Computing, Ghent University   Spring 2017
- Workshop on Mathematica, Ghent university   Autumn 2016
- Workshop on how to write research proposal. Ghent University   Autumn 2016

Selected Coursework

- E003700 - Game Theory with Engineering Applications   Autumn 2018
- E014230 - Stochastic Processes   Autumn 2017
- CS 709 - Convex Optimisation   Autumn 2013
- IE 647 - Applied Integer Programming   Autumn 2013

PROFESSIONAL EXPERIENCE

Analyst - Business Consulting   Jul. 2014 - Oct. 2015
HSBC Data Processing Centre, Bangalore, India
Global Investigation Analytics

- Worked on financial crime compliance/ risk compliance analytics for model development, deployment, validation and tuning, with multiple regions including UK, HK.
- Developed model for correspondent banking to detect suspicious activities resulting in money laundering using techniques like linear regression, forecasting, random sampling, Above the Line (ATL) and Below the Line (BTL) testing, threshold calibration and tuning.
- Validated the model based on the feedback with hypothesis testing and clustering analysis. Also, analysed scope of the model under different global scenarios.
- Incorporated important techniques like frequent alerter, hub-spoke optimisation while developing the model for different regions.
- Implemented complete model in SQL/SAS to speed up the process.
- Delivered Ad-Hoc requests on time by analysing the data in Excel/VBA/SAS and also provided support.

EXTRA-ACADEMIC ACTIVITIES

- Reviewer for Performance Evaluation, Annals of operations Research, MDPI - Mathematics, IEEE transactions on green computing
- Jury member of master thesis committee; Thesis entitled "The P2Pool mining pool - An analysis   Oct. 2018
  of a distributed cryptographically secured database".
- Volunteered at master thesis fair at Ghent university to give the information on department's   Feb. 2017
  research domains so that students can choose their thesis topic.