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February 6, 2019
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Summary

I am currently a Ph.D. student at the *Division of Decision and Control Systems* at the KTH Royal Institute of Technology. My research is centered around:

- learning and controlling stochastic dynamical systems; in particular,
- hidden Markov models (HMMs) and (partially observed) Markov decision processes;
- machine learning and optimization.

Some of the skills that I have picked up during my Ph.D. studies are: independent research and problem solving; teaching and presenting for an audience; written communication; time-management; critical thinking; algorithm implementation and evaluation; and, interdisciplinary collaboration. As part of my education at KTH, I have taught M.Sc.-level courses on *Reinforcement Learning* and *Stochastic Control and Optimization*, as well as supervised several B.Sc. and M.Sc. theses.

In general, my interests are in machine learning, data analytics and their future applications in real-world scenarios – for example, in next-generation health-care.

Selected Publications:

- **Robert Mattila**, Cristian R. Rojas, Vikram Krishnamurthy, and Bo Wahlberg. Inverse filtering for hidden Markov models. In *Advances in Neural Information Processing Systems (**NIPS**)*, 2017. [pdf]
- **Robert Mattila**, Cristian R. Rojas, Vikram Krishnamurthy, and Bo Wahlberg. Asymptotically efficient identification of known-sensor hidden Markov models. *IEEE Signal Processing Letters*, 2017. [pdf]
- **Robert Mattila**, Antti Siika, Joy Roy, and Bo Wahlberg. A Markov decision process model to guide treatment of abdominal aortic aneurysms. In *IEEE Conference on Control Applications (CCA)*, 2016. [pdf]

Education

- **KTH Royal Institute of Technology** — Stockholm, Sweden
  Ph.D., Department of Automatic Control — *2015 - 2020 (Projected)*
  - Supervisors: Prof. Bo Wahlberg and Assoc. Prof Cristian R. Rojas.
  - Topic: Exploiting structure in Markovian models so as to efficiently learn and control stochastic systems.
- **KTH Royal Institute of Technology** — Stockholm, Sweden
  Licentiate Degree. Department of Automatic Control — *March, 2018*
  - Title: *Hidden Markov models: Identification, control and inverse filtering.* [pdf]
  - Opponent: **Prof. Eric Moulines** of Ecole Polytechnique (Paris, France).
- **KTH Royal Institute of Technology** — Stockholm, Sweden
  B.Sc. Engineering Physics, M.Sc. Systems, Control and Robotics — *2010 - 2015*
  - The Swedish degree of *Civilingenjör i Teknisk Fysik*.
  - Graduated in 4.5 years, instead of nominal 5 years.
  - B.Sc. GPA of 4.98/5.0 and M.Sc. GPA of 5.0/5.0 .
- **UCM, Universidad Cumplutense de Madrid** — Madrid, Spain
  ERASMUS Exchange studies — *Spring 2013*

  - All (five) courses taken were taught in Spanish (including reading material).
  - GPA of 8.13/10.0 .

- **THG, Thorildsplans gymnasium** Stockholm, Sweden
  Natural Sciences with specialization in Mathemathics and Computer Science *2007 - 2010*
  - GPA of 20.0/20.0 .

Courses

University (Ph.D.):

- **Math:** Game Theory, Matrix Algebra, Mathematical Methods in Signals, Systems and Control (e.g., Functional Analysis)
- **Statistics:** Bayesian Networks, Probabilistic Verification and Synthesis, Probability and Random Processes, Optimal Filtering (attended lectures)
- **Machine Learning:** Partially Observed Markov Decision Processes, Convex Optimization, Stochastic Control and Optimization, Deep Learning in Data Science (attended lectures)
- **Other:** Scientific Writing, Basic Communication and Teaching, Supplementary Course in Theory and Methodology of Science, Hybrid Systems (Stability, Stabilization, Abstraction and Formal Verification)

University (M.Sc., B.Sc.):

Grade A in all courses except one B (GPA 5.0/5.0):[1]

- **Programming:** Fundamentals of Programming and Computer Science (Python, Algorithms and Data-Structures), Object-Oriented Program Construction (Java), Numerical Methods
- **Physics:** Thermodynamics, Classical Physics, Mechanics I, Mechanics II, Strength of Materials and Solid Mechanics, Modern Physics, Electromagnetic Theory, Quantum Physics, Statistical Physics, Fluid Mechanics, Atmospheric Physics, Geophysics, Solid-State Physics
- **Math:** Linear Algebra, Single-Variable Calculus, Multi-Variable Calculus, Complex Analysis, Differential Equations and Transforms II, Mathematical Methods in Physics (Vector Analysis, Partial Differential Equations), Probability Theory and Statistics
- **Systems:** Automatic Control, Modelling of Dynamical Systems, Mathematical Systems Theory, Nonlinear Control, Hybrid and Embedded Control Systems, Geometric Control Theory, Advanced Control Theory and Practice, Optimal Control Theory
- **Other:** Spanish B1, Spanish B2, Theory and Methodology of Science

Other:

- NVIDIA Deep Learning Institute:
  - *Fundamentals of Deep Learning for Computer Vision*
    - `https://courses.nvidia.com/certificates/20ceae161e844e13a5a3ea35cf15e905`
  - *Medical Image Segmentation with DIGITS*
  - *Image Segmentation with TensorFlow*

[1] Grading scale: Excellent (A), Very Good (B), Good (C), Satisfactory (D), Sufficient (E).

Skills, Merits and Awards

- **Computer Skills:**

Programming:	Matlab, Python, Julia, Java
Operating Systems:	OSX, Linux, Windows
Other:	LaTeX, git

- **Languages:** Swedish (native), English (fluent) and Spanish (intermediate).
- **Awards:**
  - Awarded Jubilee Appropriation from the Knut and Alice Wallenberg foundation in 2018.
  - Awarded the KTH Electrical Engineering Scholarship of Excellence (1 MSEK) in 2015.
  - Awarded travel scholarship from the Borgquist Foundation in 2015.
  - Awarded a SURF scholarship from Caltech to work with Prof. Richard Murray in 2014.
  - Awarded the Henrik Göransson's Sandviken Scholarship and the KTH Student Scholarship (twice) for outstanding grades during B.Sc. and M.Sc. studies.
  - Participated in the final of *Wallenbergs Fysikpris 2010* (Swedish qualifications for the International Physics Olympiad).
  - Awarded scholarship for outstanding grades when graduating from THG.
- **Reviewer** for:
  - IFAC American Control Conference (ACC),
  - IFAC European Control Conference (ECC),
  - IFAC Automatica journal,
  - IEEE Conference on Decision and Control (CDC),
  - IEEE Transactions on Automatic Control (TAC),
  - ACL Conference on Learning Theory (COLT),
  - IEEE Signal Processing Letters (SPL).
- **KIBok** (`www.kibok.se`): A website for buying and selling used medical textbooks, aimed for students at the Karolinska Institute. The website was developed using Python and Django, and has been running since 2013.
- Hold a Swedish driver's license (B).

Teaching

- **EL2805 Reinforcement Learning** KTH
  Teaching assistant, 120 students *Autumn 2018*

  The course provides an in-depth treatment of the modern theoretical tools used to devise and analyse RL algorithms. It includes an introduction to RL and to its classical algorithms such as Q-learning, and SARSA, but further presents the rationale behind the design of more recent algorithms, such as those striking optimal trade-off between exploration and exploitation. The course also covers algorithms used in recent RL success stories, e.g., deep RL algorithms.

- **EL2800 Stochastic Control and Optimization** KTH
  Teaching assistant *Autumn 2017*

  This course introduces basic theories and methodologies for the analysis and the design of stochastic control policies, including: Markov chains, Markov Decision Process (MDP), Dynamic Programming and value / policy iteration methods, design of approximate controllers for MDPs, stochastic linear quadratic control and Multi-Armed Bandit problems.

- **EL1000 Automatic Control** KTH
  Teaching assistant *Autumn 2016*

  An introductory course on control systems. It provides the students with the basic engineering knowledge of dynamic systems and feedback.

- **EL1000 Automatic Control** KTH
  Teaching assistant *Autumn 2015*

  See above.

Supervision

- **Bachelor Thesis** KTH
  Supervisor of Ossian Krödel and Rasmus Jerndal *Spring 2018*
  - Title: *Portfolio Optimization with Market State Analysis*

- **Bachelor Thesis** KTH
  Supervisor of Gustav Ekman and Fredrik Rubin *Spring 2018*
  - Title: *Portfolio Inversion: Finding Market State Probabilities from Optimal Portfolios*

- **Master Thesis** KTH
  Supervisor of Daniel Merkoulova *Spring 2017*
  - Title: *Optimal Input Design by Model Predictive Control for System Identification*

- **EH1010 Project Course in Electrical Engineering** KTH
  Supervisor of six students *Spring 2016*
  - Modeling and designing various control architectures for a segway. Implementation in Java.

Academic and Professional Experience

- **International Conference on Machine Learning (ICML'18)** Stockholm, Sweden
  Attended the conference, tutorials and workshops *Summer 2018*
- **IFAC Symposium on System Identification (SYSID'18)** Stockholm, Sweden
  Volunteer in the organizing crew *Summer 2018*
- **Cornell Tech, Cornell University** Manhattan, USA
  Invited researcher by Prof. Vikram Krishnamurthy *Summer 2017*
  - Worked on inverse problems for Bayesian optimal filters.
- **VUB-ELEC, Workshop on System Identification** Brussels, Belgium
  Included courses on *Summer 2017*
  - Frequency response function measurements (non-parametric tools), dynamic system identification (parametric tools) and control-oriented system identification by, among others, John Lataire, Yves Rolain, Rik Pintelon, Ivan Markovsky, Philippe Dreesen and Simone Formentin.
- **S^{3}CS, Swedish Summer School in Computer Science** Djurö, Sweden
  The courses were taught by *Summer 2016*
  - Michael Mitzenmacher (Hashing Algorithms);
  - Sergei Vassilvitskii (Algorithms for Modern Parallel Systems).
- **UBC, University of British Columbia** Vancouver, Canada
  Invited researcher by Prof. Vikram Krishnamurthy *Summer 2015*
  - Worked on method of moments for hidden Markov models.
- **UBC, University of British Columbia** Vancouver, Canada
  Master thesis with Prof. Vikram Krishnamurthy *Autumn 2014*

- **Caltech, California Institute of Technology** Pasadena, USA
  SURF in the Control and Dynamical Systems (CDS) group *Summer 2014*
  - Supervisors: Prof. Richard M. Murray and Asst. Prof. Yilin Mo
  - Developed an improved abstraction algorithm for the correct-by-construction controller synthesis framework `TuLiP` (implemented in Python).
- **KTH, Royal Institute of Technology** Stockholm, Sweden
  Research intern for Prof. Bo Wahlberg *Summer 2013*
- **ZJU, Zhejiang University** Hangzhou, China
  Participated in the Joint Research Center of Photonics Workshop *Summer, 2012*
  - Implemented optical logic gates exploiting non-linearities in fibers.
- **Stockholm Vatten AB** Stockholm, Sweden
  Summer intern *Summer 2012*
- **Stockholm Vatten AB** Stockholm, Sweden
  Summer intern *Summer 2011*
  - Warehouse work including: collecting and delivering items; cleaning and repairing machines; contacting customers; administrative work in the supply system Agresso.

References

Available upon request.

Publications

Journals

- Robert Mattila, Cristian R. Rojas, Vikram Krishnamurthy, and Bo Wahlberg. Asymptotically efficient identification of known-sensor hidden Markov models. *IEEE Signal Processing Letters*, 24(12):1813–1817, 2017.

Conferences

- Robert Mattila, Cristian R. Rojas, Vikram Krishnamurthy, and Bo Wahlberg. Inverse filtering for linear Gaussian state-space systems. In *Proceedings of the 57th IEEE Conference on Decision and Control (CDC'18)*, 2018.
- Roberto G. Ramírez-Chavarría, Gustavo Quintana-Carapia, Matias I. Müller, Robert Mattila, Daniel Matatagui, Celia Sánchez-Pérez, Bioimpedance parameter estimation using fast spectral measurements and regularization. In *Proceedings of the 18th IFAC Symposium on System Identification (SYSID'18)*, 2018.
- Robert Mattila, Cristian R. Rojas, Vikram Krishnamurthy, and Bo Wahlberg. Inverse filtering for hidden Markov models. In *Advances in Neural Information Processing Systems (**NIPS'17**)*, pages 4207–4216, 2017.
- Robert Mattila, Cristian R. Rojas, Vikram Krishnamurthy, and Bo Wahlberg. Identification of hidden Markov models using spectral learning with likelihood maximization. In *Proceedings of the 56th IEEE Conference on Decision and Control (CDC'17)*, pages 5859–5864, 2017.
- Antti Siika, Robert Mattila, Bo Wahlberg, and Joy Roy. An optimal gender- specific treatment policy for abdominal aortic aneurysms constructed using a Markov decision process model. *Journal of Vascular Surgery*, 65(6, Supplement):175S, 2017. Abstracts of the 2017 Vascular Annual Meeting (VAM'17).
- Robert Mattila, Cristian R. Rojas, Vikram Krishnamurthy, and Bo Wahlberg. Computing monotone policies for Markov decision processes: a nearly-isotonic penalty approach. In *Proceedings of the 20th IFAC World Congress*, volume 50, pages 8429 – 8434, 2017.

- Robert Mattila, Antti Siika, Joy Roy, and Bo Wahlberg. A Markov decision process model to guide treatment of abdominal aortic aneurysms. In *Proceedings of the IEEE Conference on Control Applications (CCA'16)*, pages 436–441, 2016.
- Robert Mattila, Vikram Krishnamurthy, and Bo Wahlberg. Recursive identifi- cation of chain dynamics in hidden Markov models using non-negative matrix factorization. In *Proceedings of the 54th IEEE Conference on Decision and Control (CDC'15)*, pages 4011–4016, 2015.
- Robert Mattila, Yilin Mo, and Richard M. Murray. An iterative abstraction algorithm for reactive correct-by-construction controller synthesis. In *Proceedings of the 54th IEEE Conference on Decision and Control (CDC'15)*, pages 6147–6152, 2015.
- Robert Mattila, Cristian R. Rojas, and Bo Wahlberg. Evaluation of spectral learning for the identification of hidden Markov models. *Proceedings of the 17th IFAC Symposium on System Identification (SYSID'15)*, 48(28):897–902, 2015.

Theses

- Robert Mattila, *Hidden Markov models: Identification, control and inverse filtering.* Licentiate thesis, KTH Royal Institute of Technology. Stockholm, Sweden, 2018. Supervisors: Prof. Bo Wahlberg and Assoc. Prof. Cristian R. Rojas.
- Robert Mattila, *On Identification of Hidden Markov Models Using Spectral and Non-Negative Matrix Factorization Methods.* Master's thesis, KTH Royal Institute of Technology. Stockholm, Sweden, 2015. Supervisors: Prof. Bo Wahlberg and Assoc. Prof. Cristian R. Rojas.
- Robert Mattila, *Including Bathymetric Data in Autonomous Surface Vessels' Maneuvering Optimisation Tool.* Bachelor's thesis, KTH Royal Institute of Technology, Stockholm, and Universidad Cumplutense de Madrid (UCM), 2013. Supervisors: Prof. Juan Jiménez and José María Benítez.

Other

- Robert Mattila, Cristian R. Rojas, Vikram Krishnamurthy and Bo Wahlberg, *Method of Moments for Learning Hidden Markov models.* Poster at the 2018 Workshop of the European Research Network on System Identification (ERNSI), September, Cambridge, UK.
- Robert Mattila, Cristian R. Rojas, Vikram Krishnamurthy and Bo Wahlberg, *Inverse Filtering for Linear Gaussian State-Space Models.* Presentation at the 2018 Swedish Control Conference (Reglermötet), June, Stockholm, Sweden.
- Robert Mattila, Cristian R. Rojas, Vikram Krishnamurthy and Bo Wahlberg, *Inverse Filtering for Hidden Markov Models.* Poster at the 2018 WASP AI4X Industry, February, Stockholm, Sweden.
- Robert Mattila, Cristian R. Rojas, Vikram Krishnamurthy and Bo Wahlberg, *Inverse Filtering for Hidden Markov Models.* Poster at the 2017 Workshop of the European Research Network on System Identification (ERNSI), September, Lyon, France.
- Robert Mattila, Cristian R. Rojas, Vikram Krishnamurthy and Bo Wahlberg, *Method of Moments Identification of Hidden Markov Models with Known Sensor Uncertainty Using Convex Optimization.* Poster at the 2016 Workshop of the European Research Network on System Identification (ERNSI), September, Cison di Valmarino, Italy.
- Robert Mattila, Cristian R. Rojas, Vikram Krishnamurthy and Bo Wahlberg, *Method of Moments Identification of Hidden Markov Models with Known Sensor Uncertainty Using Convex Optimization.* Poster at Reglermötet 2016, June, Göteborg, Sweden.
- Robert Mattila, Vikram Krishnamurthy and Bo Wahlberg, *Recursive Method of Moments Identification of Hidden Markov Models using Convex Optimization.* Poster at the 2015 Workshop of the European Research Network on System Identification (ERNSI), September, Varberg, Sweden.