Robert Mattila

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Summary

I graduated from the Engineering Physics (Teknisk Fysik) programme of KTH in 2015 with a masters in Systems, Control and Robotics. Since then, I have been a Ph.D.-student at the Division of Decision and Control Systems under the supervision of Prof. Bo Wahlberg. I successfully defended and received my licentiate degree in 2018. My research is centered around:

- learning and controlling stochastic dynamical systems,
- 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,
- student (project/thesis) supervision,
- interdisciplinary collaboration.

I am interested in opportunities related to 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., Division of Decision and Control Systems — *2015 - 2020 (Projected)*
  - Supervisors: Prof. Bo Wahlberg and Assoc. Prof Cristian R. Rojas.
  - Topic: *Learning, controlling and applying hidden Markov models.*
- **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 5.0/5.0 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:**
  - Mathematical Methods in Signals, Systems and Control (e.g., Functional Analysis)
  - Game Theory
  - Matrix Algebra
- **Statistics:**
  - Bayesian Networks
  - Probabilistic Verification and Synthesis
  - Probability and Random Processes
  - Optimal Filtering[1]
- **Machine Learning:**
  - Partially Observed Markov Decision Processes
  - Convex Optimization
  - Stochastic Control and Optimization
  - Deep Learning in Data Science[1]
  - Distributed Optimization[1]
  - Mathematical Foundations of Machine Learning[1]
- **Other:**
  - Scientific Writing
  - Basic Communication and Teaching
  - Supplementary Course in Theory and Methodology of Science
  - Hybrid Systems (Stability, Stabilization, Abstraction and Formal Verification)

[1] Attended lectures.

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

Grade A in all courses except one B (GPA 5.0/5.0):[2]

- **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
  - 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/51f99eac7a2e492b8aaa7aa83025bd33`
  - *Medical Image Segmentation with DIGITS*
  - *Image Segmentation with TensorFlow*
  - *Deep Learning Workflows with TensorFlow, MXNet and NVIDIA-Docker*
- fast.ai: Practical Deep Learning for Coders, v3

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.

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

- 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.

- I have written **reviews** for:
  - IFAC American Control Conference (ACC),
  - IFAC European Control Conference (ECC),
  - IFAC Automatica journal,
  - IEEE Conference on Decision and Control (CDC),
  - ACL Conference on Learning Theory (COLT),
  - IEEE Transactions on Automatic Control (TAC),
  - IEEE Signal Processing Letters (SPL),
  - Neural Information Processing Systems (NeurIPS).

- **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.

  Selected feedback from the course evaluation:
  "*Robert is a great tutor*", "*Robert Mattila goes the extra mile when teaching*"

- **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.

  Selected feedback from the course evaluation:
  "*Extra stort tack till Robert och Emma, två grymma assar*", "*Övningsledarna Emma och Robert var väldigt pedagogiska och lärde en mycket*"

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

  See above.

Student 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 (responsible for scheduling, technical support, etc.) — *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

- Roberto G. Ramírez-Chavarría, Matias I. Müller, Robert Mattila, Gustavo Quintana-Carapia, Celia Sánchez-Pérez, A Framework for High-Resolution Frequency Response Measurement and Parameter Estimation in Microscale Impedance Applications. *Measurement*, 2019.

- Robert Mattila, Inês Lourenço, Cristian R. Rojas, Vikram Krishnamurthy, Bo Wahlberg. Estimating Private Beliefs of Bayesian Agents Based on Observed Decisions. *IEEE Control Systems Letters*, 3(3):523-528, 2019.

- 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.