



Robert Mattila

Malvinas väg 10
114 28 Stockholm
KTH EECS-DCS, Sweden

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rmattila@kth.se
+46 (0)76 - 201 405 6
rmattila.github.io

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 Ph.D. degree in June, 2020.

My research is centered around:

- learning and controlling stochastic dynamical systems,
- hidden Markov models (HMMs) and 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, Eric Moulines, Vikram Krishnamurthy, and Bo Wahlberg. Fast and consistent learning of hidden Markov models by incorporating non-consecutive correlations. In *International Conference on Machine Learning (ICML)*, 2020.
- **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**
Ph.D., Division of Decision and Control Systems
 - Supervisors: Prof. Bo Wahlberg and Assoc. Prof Cristian R. Rojas.
 - Topic: *Hidden Markov Models: Identification, Inverse Filtering and Applications*. [pdf]
 - Committee: **Prof. John Lygeros** (opponent), **Prof. Jan H. van Schuppen**, **Prof. Tobias Rydén**, and **Assist. Prof. Ayça Özçelikkale**
 - **KTH Royal Institute of Technology**
Licentiate, Department of Automatic Control
 - Supervisors: Prof. Bo Wahlberg and Assoc. Prof Cristian R. Rojas.
 - Title: *Hidden Markov models: Identification, control and inverse filtering*. [pdf]
 - Opponent: **Prof. Eric Moulines** of Ecole Polytechnique (Paris, France).
 - **KTH Royal Institute of Technology**
B.Sc. Engineering Physics, M.Sc. Systems, Control and Robotics
 - 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 Complutense de Madrid**
ERASMUS Exchange studies
 - All (five) courses taken were taught in Spanish (including reading material).
 - GPA of 8.13/10.0 .
 - **THG, Thorildsplans gymnasium**
Natural Sciences with specialization in Mathematics and Computer Science
 - GPA of 20.0/20.0 .

Stockholm, Sweden
2015 - 2020

Stockholm, Sweden
March, 2018

Stockholm, Sweden
2010 - 2015

Madrid, Spain
Spring 2013

Stockholm, Sweden
2007 - 2010

Courses

University (Ph.D.):

- **Mathematics:**
 - Mathematical Methods in Signals, Systems and Control (e.g., Functional Analysis)
 - Game Theory
 - Matrix Algebra
- **Statistics:**
 - Bayesian Networks
 - Probability and Random Processes
 - Probabilistic Verification and Synthesis
 - Optimal Filtering¹
- **Machine Learning:**
 - Partially Observed Markov Decision Processes
 - Deep Learning in Data Science¹
 - Convex Optimization
 - Distributed Optimization¹
 - Stochastic Control and Optimization
 - Mathematical Foundations of Machine Learning¹
- **Other:**
 - Scientific Writing
 - Hybrid Systems (Stability, Stabilization, Abstraction and Formal Verification)
 - Basic Communication and Teaching
 - Theory and Methodology of Science

¹Attended 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

- **Mathematics:**

- 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:** L^AT_EX, git

- **Languages:** Swedish (native), English (fluent) and Spanish (intermediate).

- **Awards:**

- Awarded Jubilee Appropriation from the Knut and Alice Wallenberg foundation in 2018.

²Grading 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 second-hand textbooks, aimed at students at the Karolinska Institute. The website was developed using Python and Django, and was running between 2013 and 2019.
 - 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**
Teaching assistant
 See above.

KTH
Autumn 2015

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 Merkoulouva *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

- **Cornell University** Ithaca, USA
Invited researcher by Prof. Vikram Krishnamurthy *Summer 2019*
 – Worked on inverse filtering problems for counter-adversarial autonomous systems.
- **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** 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.
- **S³CS, 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 estimators 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.

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, Eric Moulines, Vikram Krishnamurthy, and Bo Wahlberg. Fast and Consistent Learning of Hidden Markov Models by Incorporating Non-Consecutive Correlations. In the *37th International Conference on Machine Learning (ICML'20)*, 2020.
- Robert Mattila, Inês Lourenço, Vikram Krishnamurthy, Cristian R. Rojas, Bo Wahlberg. What Did Your Adversary Believe? Optimal Filtering and Smoothing in Counter-Adversarial Autonomous Systems. In *Proceedings of the 45th International Conference on Acoustics, Speech, and Signal Processing (ICASSP'20)*, 2020.
- Robert Mattila, Inês Lourenço, Cristian R. Rojas, Vikram Krishnamurthy, Bo Wahlberg. Estimating Private Beliefs of Bayesian Agents Based on Observed Decisions. Presented at *the 58th IEEE Conference on Decision and Control (CDC'19)*, 2019.
- 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 identification 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, Inverse Filtering and Applications*. Ph.D. thesis, KTH Royal Institute of Technology. Stockholm, Sweden, 2020. Supervisors: Prof. Bo Wahlberg and Assoc. Prof. Cristian R. Rojas.
- 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 Complutense de Madrid (UCM), 2013. Supervisors: Prof. Juan Jiménez and José María Benítez.

Other

- Robert Mattila, Inês Lourenço, Cristian R. Rojas, Vikram Krishnamurthy and Bo Wahlberg, *Estimating Private Beliefs Based on Observed Decisions*. Poster at the 2019 Workshop of the European Research Network on System Identification (ERNSI), September, Maastricht, the Netherlands.
- 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.