Ivan Markovsky's Curriculum Vitae

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Biographical sketch

I obtained my PhD in electrical engineering from the Katholieke Universiteit Leuven in 2005. Since then, I was teaching and doing research in control and system theory at the School of Electronics and Computer Science of the University of Southampton and the ELEC department of the Vrije Universiteit Brussel, where I am currently an associate professor. My expertise is in structured low-rank approximation, system identification, and data-driven control, topics on which I've published over 100 peer-reviewed papers, 11 book chapters, and 2 monographs. I am an associate editor of the International Journal of Control. In 2011, I was awarded an ERC starting grant.

Education

- 02/2005 PhD in electrical engineering, Katholieke Universiteit Leuven, Belgium
  Title: Exact and approximate modeling in the behavioral setting
  Supervisors: Sabine Van Huffel, Bart De Moor, and Jan C. Willems
- BS (06/1997) and MS (06/1998) in control engineering, Technical University of Sofia, Bulgaria

Positions

- 10/2012–present research professor, Vrije Universiteit Brussel, Belgium
- 01/2007–09/2012 lecturer, University of Southampton, UK
- 03/2005–12/2006 postdoctoral researcher, Katholieke Universiteit Leuven, Belgium
- 02/2005–03/2005 visiting researcher, CNR, Bari and CINECA, Bologna, Italy
- 11/2000–02/2005 PhD researcher, Katholieke Universiteit Leuven, Belgium
- 01/2000–09/2000 teaching assistant, Technical University of Sofia, Bulgaria
- 08/1998–12/1999 research assistant, University of Notre Dame, USA

Research interests

My main research interests are computational methods for system theory, identification, and control:

- structured low-rank approximation and completion
- system identification in the behavioral setting
- data-driven signal processing and control

Research record

- 2 monographs published by Springer (sole author) and SIAM (main author)
- 11 book chapters (sole author for 3, main author for 6) published by Kluwer, Springer, CRC, IET
- 61 journal papers (sole author for 12, main author for 24)
- 49 refereed conference papers (sole author for 7, main author for 29)

Recent teaching activities

My vision for education is to base teaching on *student-centered activities,* involving discussions, problem solving, and project work. An example of a course build on these principles is described in

> I. Markovsky. Dynamical systems and control mindstorms. In proc. of the *20th Mediterranean Conference on Control and Automation*, pages 54–59, Barcelona, Spain, 2012.

Since 2012, I am teaching 3 master-level courses in systems and control per year. In addition, I taught

- 06/2017 and 06/2019 PhD course on "Data-driven design: A missing data approach", *ELEC workshop on System Identification*, Brussels, Belgium
- 10/2016 series of lectures on "Structured low-rank approximation", delivered at the *Data Analysis master course*, Deportment Computational Mathematics, Antwerpen

Supervision of PhD students

- 2017–2020, A. Fazzi, "Matrix nearness problems with applications" (co-supervisor)
- 2016–2020, G. Quintana Carapia, "Data-driven dynamic measurement"
- 2013–2016, S. Rhode, "Robust and regularized system identification" (co-supervisor)
- 2008–2012, M. Przedwojski, "Analysis of synchronization errors" (co-supervisor)
- 2007–2011, F. Le, "Identification of electrically stimulated muscle after stroke"

Supervision of postdocs

- 2019–present, A. Fazzi, "Structured low-rank approximation"
- 2019–present, V. Mishra, "Data-driven signal processing"
- 2019–2020, B. Grossmann, "Data-driven signal processing"
- 2018–2020, P. Dreesen, "Convex relaxations for data-driven control"
- 2013–2015, 2018–2019, M. Ishteva, "Tensor approximations"
- 2011–2014, K. Usevich, "Structured low-rank approximation"

Organization of scientific meetings

- 08/2020 co-organizer data-driven control session, *24th Symposium MTNS*, Cambridge
- 12/2019 organizer low-rank approximation session, *58th IEEE Conf. Decision and Control*, Nice

- 03/2015 organizing committee, *38th Benelux Meeting on Systems and Control*, Lommel
- 08/2017 co-organizer tensor decompositions session, *SIAM Appl. Algebraic Geometry*, Atlanta
- 03/2017 organizing committee, *36th Benelux Meeting on Systems and Control*, Spa
- 03/2015 organizing committee, *34th Benelux Meeting on Systems and Control*, Lommel
- 07/2014 co-organizer of low-rank approximation sessions, *21st Symposium MTNS*, Groningen
- 09/2013 organizer of low-rank approximation session, *Dolomites Research Week*, Canazei
- 08/2006 co-organizer, *4th Int. Workshop on Total Least Squares and EIV Modeling*, Leuven

Academic service and advisory role

- 01/2007–present associate editor of the *International Journal of Control*
- 01/2019–present BE-MATHS-IN representative for the VUB
- 01/2015–12/2017 associate editor of the *SIAM Journal on Matrix Analysis and Applications*
- 07/2013 editorial board member of the *ROKS Workshop*
- 07/2012 scientific committee of the *IFAC Symp. on System Identification*

Funding ID

acronym	status	my role	agency	number	period	amount
SeLMA	current	PI	FWO	30468160	01/2018–12/2021	540K
VOLTERRA	current	PI	FWO	G090117N	01/2017–12/2020	192K
DECOUPL	current	PI	FWO	G028015N	01/2015–12/2018	252K
SLRA	past	PI	ERC	ERC-StG 258581	01/2011–12/2015	782K

Invited plenary presentations in the last two years

- 06/2021 "A matrix completion approach to data-driven control", Applications of Low Rank Matrix Completion, Fields Institute, Canada
- 10/2019 "Sparsity in system identification and data-driven control", OptML: Optimization and Machine Learning, Southampton
- 04/2019 "A low-rank matrix completion approach to data-driven signal processing", IfA-IDSC Control Seminar Series, ETH Zurich
- 08/2018 "The no free lunch principle in data modeling", *BioTensors workshop*, Leuven
- 06/2018 "Sum-of-exponentials modeling", *Approximation and Matrix Functions*, Lille

Prizes, awards, and indicators of external recognition

- 03/2012 10-year research mandate by the VUB research council
- 08/2010 ERC starting grant (ERC-StG 258581)
- 06/2008 Alston Householder Prize, honorable mention awarded at the *XVII Householder Symp.*

- 02/2005 PhD summa cum laude with congratulations of the Board of Examiners
- 08/2004 Wolfram research award at the *COMPSTAT conference*, Prague, Czech Republic

Recent collaborations

- F. Dörfler (ETH-Zurich) on data-driven control
- A. Takeda (University of Tokyo) on low-rank approximation
- K. Usevich (CNRS, Nancy) on low-rank approximation methods
- G. Mercère (Université de Poitiers, France) on subspace methods with prior knowledge
- N. Guglielmi (GSSI, Italy) on approximate GCD computation
- S. Formentin (Politecnico di Milano) on data-driven control

Selected publications

My PhD work on the *total least-squares*

> I. Markovsky and S. Van Huffel. "Overview of total least squares methods". In: *Signal Processing* 87 (2007), pp. 2283–2302. doi: 10.1016/j.sigpro.2007.04.004

and *system identification in the behavioral setting*

> I. Markovsky et al. *Exact and Approximate Modeling of Linear Systems: A Behavioral Approach*. SIAM, 2006. doi: 10.1137/1.9780898718263

lead me to the concept of the *structured low-rank approximation*

> I. Markovsky. "Structured low-rank approximation and its applications". In: *Automatica* 44.4 (2008), pp. 891–909. doi: 10.1016/j.automatica.2007.09.011

Specific contributions of my work on low-rank approximation, are recognizing the role of the matrix structure and developing fast methods for applications in system theory, signal processing, and computer algebra. Having published over 40 papers, a monograph

> I. Markovsky. *Low Rank Approximation: Algorithms, Implementation, Applications*. Springer, 2012. doi: 10.1007/978-1-4471-2227-2

and having developed with K. Usevich the SLRA software package, which incorporates the current state-of-the-art methods, I have established expertise in this fast growing research topic.

In 2008, I became interested in *data-driven control*. Leveraging on prior work in subspace identification, I developed with P. Rapisarda a data-driven linear quadratic tracking method

> I. Markovsky and P. Rapisarda. "Data-driven simulation and control". In: *Int. J. Contr.* 81.12 (2008), pp. 1946–1959. doi: 10.1080/00207170801942170

A fundamentally new idea of our approach is the construction of system's responses directly from data without knowing the system. This idea has applications beyond data-driven control.

In recent work, K. Usevich and I

> I. Markovsky and K. Usevich. "Structured low-rank approximation with missing data". In: *SIAM J. Matrix Anal. Appl.* 34.2 (2013), pp. 814–830. doi: 10.1137/120883050

laid the foundation for *missing data estimation*. We make no assumptions about the nature or distribution of the missing values and can treat simultaneously missing, exact, and noisy data. The classical motivation for missing data estimation is dealing with sensor failures. A *key novel idea* of

> I. Markovsky. "A missing data approach to data-driven filtering and control". In: *IEEE Trans. Automat. Contr.* 62 (4 Apr. 2017), pp. 1972–1978. issn: 1558–2523. doi: 10.1109/TAC.2016.2591178

is to use missing data for solving signal processing and control problem, where the *missing data is what we aim to compute*. This idea, *connects my major research topics*—low-rank approximation and data-driven control.

Research output overview

Number of publications per category:

A	scientific monographs	2
B	articles in books	11
C	articles in journals	61
D	articles in conference proceedings	49

Number of citations as of 26 October 2020:

1629	Web of Science (WoS)	h-index 18
4423	Google Scholar (GS)	h-index 28

Pdf files and computer code, implementing the methods and allowing reproducibility of the results, are available from: http://homepages.vub.ac.be/~imarkovs/publications.html

A. Scientific monographs

A.1. I. Markovsky. *Low-Rank Approximation: Algorithms, Implementation, Applications*. 2nd edition. Springer, 2019. isbn: 978-3-319-89619-9. doi: 10.1007/978-3-319-89620-5.

A.2. I. Markovsky. *Low Rank Approximation: Algorithms, Implementation, Applications*. Springer, 2012. doi: 10.1007/978-1-4471-2227-2.

A.3. I. Markovsky, J. C. Willems, S. Van Huffel, and B. De Moor. *Exact and Approximate Modeling of Linear Systems: A Behavioral Approach*. SIAM, 2006. doi: 10.1137/1.9780898718263.

B. Articles in monographs (internationally peer reviewed)

B.1. I. Markovsky. "Dynamic measurement". In: *Data-driven filtering and control design: Methods and applications*. IET, 2019. Chap. 6, pp. 97–108. doi: 10.1049/PBCE123E_ch6.

B.2. I. Markovsky and P.-L. Dragotti. "Using structured low-rank approximation for sparse signal recovery". In: *Latent Variable Analysis and Signal Separation*. Lecture Notes in Computer Science. Springer, 2018, pp. 479–487. doi: 10.1007/978-3-319-93764-9_44.

B.3. I. Markovsky, A. Fazzi, and N. Guglielmi. "Applications of polynomial common factor computation in signal processing". In: *Latent Variable Analysis and Signal Separation*. Lecture Notes in Computer Science. Springer, 2018, pp. 99–106. doi: 10.1007/978-3-319-93764-9_10.

B.4. I. Markovsky. “System identification in the behavioral setting: A structured low-rank approximation approach”. In: *Latent Variable Analysis and Signal Separation*. Ed. by E. Vincent et al. Vol. 9237. Lecture Notes in Computer Science. Springer, 2015, pp. 235–242. isbn: 978-3-319-22481-7. doi: 10.1007/978-3-319-22482-4_27.

B.5. I. Markovsky. “Rank constrained optimization problems in computer vision”. In: *Regularization, Optimization, Kernels, and Support Vector Machines*. Ed. by A. Argyriou J. Suykens M. Signoretto. Pattern Recognition. Chapman & Hall/CRC Machine Learning, 2014. Chap. 13, pp. 293–312. isbn: 9781482241396. doi: 10.1201/b17558-16.

B.6. I. Markovsky and K. Usevich. “Nonlinearly structured low-rank approximation”. In: *Low-Rank and Sparse Modeling for Visual Analysis*. Ed. by Yun Raymond Fu. Springer, 2014, pp. 1–22. doi: 10.1007/978-3-319-12000-3_1.

B.7. I. Markovsky. “Algorithms and literate programs for weighted low-rank approximation with missing data”. In: ed. by A. Iske et al. Vol. 3. Springer, 2011. Chap. 12, pp. 255–273. doi: 10.1007/978-3-642-16876-5_12.

B.8. I. Markovsky, A. Amann, and S. Van Huffel. “Application of filtering methods for removal of resuscitation artifacts from human ECG signals”. In: *System Identification, Environmental Modelling, and Control System Design*. Ed. by L. Wang, H. Garnier, and T. Jakeman. Springer, 2009. doi: 10.1007/978-0-85729-974-1_14.

B.9. I. Markovsky and S. Van Huffel. “On weighted structured total least squares”. In: *Large-Scale Scientific Computing*. Ed. by I. Lirkov, S. Margenov, and J. Waśniewski. Vol. 3743. Lecture Notes in Computer Science. Springer–Verlag, 2006, pp. 695–702. doi: 10.1007/11666806_80.

B.10. A. Kukush, I. Markovsky, and S. Van Huffel. “Consistent estimation of an ellipsoid with known center”. In: *Comput. Stat. (COMPSTAT)*. Ed. by J. Antoch. Physica–Verlag, 2004, pp. 1369–1376. isbn: 3-7908-1554-3. doi: 10.1007/s00211-004-0526-9.

B.11. A. Kukush, I. Markovsky, and S. Van Huffel. “On consistent estimators in linear and bilinear multivariate errors-in-variables models”. In: *Total Least Squares and Errors-in-Variables Modeling: Analysis, Algorithms and Applications*. Ed. by S. Van Huffel and P. Lemmerling. Kluwer, 2002, pp. 155–164. doi: 10.1007/978-94-017-3552-0_14.

C. Articles in journals (internationally peer reviewed)

C.1. A. Fazzi, N. Guglielmi, and I. Markovsky. “A gradient system approach for Hankel structured low-rank approximation”. In: *Linear Algebra Appl.* (2021). doi: 10.1016/j.laa.2020.11.016.

C.2. A. Fazzi, N. Guglielmi, and I. Markovsky. “Generalized algorithms for the approximate matrix polynomial GCD of reducing data uncertainties with application to MIMO system and control”. In: *J. Comput. Appl. Math.* (2021). doi: 10.1016/j.cam.2021.113499.

C.3. V. Mishra and I. Markovsky. “The Set of Linear Time-Invariant Unfalsified Models with Bounded Complexity is Affine”. In: *IEEE Trans. Automat. Contr.* (2021). doi: 10.1109/TAC.2020.3046235.

C.4. G. Q. Carapia and I. Markovsky. “Input parameters estimation from time-varying measurements”. In: *Measurement* 153 (2020), p. 107418. doi: https://doi.org/10.1016/j.measurement.2019.107418.

C.5. G. Q. Carapia, I. Markovsky, R. Pintelon, P. Csurcsia, and D. Verbeke. “Bias and covariance of the least squares estimate in a structured errors-in-variables problem”. In: *Comput. Statist. Data Anal.* 144 (2020), p. 106893. doi: 10.1016/j.csda.2019.106893.

C.6. G. Q. Carapia, I. Markovsky, R. Pintelon, P. Csurcsia, and D. Verbeke. “Experimental validation of a data-driven step input estimation method for dynamic measurements”. In: *IEEE Transactions on Instrumentation and Measurement* 69 (7 2020), pp. 4843–4851. doi: 10.1109/TIM.2019.2951865.

C.7. T. Liu, I. Markovsky, T.-K. Pong, and A. Takeda. “A hybrid penalty method for a class of optimization problems with multiple rank constraints”. In: *SIAM J. Matrix Anal. Appl.* 41 (3 2020), pp. 1260–1283. doi: 10.1137/19M1269919.

C.8. I. Markovsky, T. Liu, and A. Takeda. “Data-driven structured noise filtering via common dynamics estimation”. In: *IEEE Trans. Signal Process.* 68 (1 2020), pp. 3064–3073. doi: 10.1109/TSP.2020.2993676.

C.9. V. Mishra, I. Markovsky, and B. Grossmann. “Data-Driven Tests for Controllability”. In: *Control Systems Letters* 5 (2 2020), pp. 517–522. doi: 10.1109/LCSYS.2020.3003770.

C.10. I. Markovsky. “On the behavior of autonomous Wiener systems”. In: *Automatica* 110 (2019), p. 108601. doi: https://doi.org/10.1016/j.automatica.2019.108601.

C.11. M. Zhang, I. Markovsky, C. Schretter, and J. D’hooge. “Compressed Ultrasound Signal Reconstruction using a Low-rank and Joint-sparse Representation Model”. In: *Transactions on Ultrasonics, Ferroelectrics, and Frequency Control* 66 (7 2019), pp. 1232–1245. doi: 10.1109/TUFFC.2019.2915096.

C.12. A. Fazzi, N. Guglielmi, and I. Markovsky. “An ODE based method for computing the Approximate Greatest Common Divisor of polynomials”. In: *Numerical algorithms* 81 (2 2018), pp. 719–740. doi: 10.1007/s11075-018-0569-0.

C.13. N. Guglielmi and I. Markovsky. “An ODE based method for computing the distance of co-prime polynomials to common divisibility”. In: *SIAM Journal on Numerical Analysis* 55 (3 2017), pp. 1456–1482. doi: 10.1137/15M1018265.

C.14. I. Markovsky. “A missing data approach to data-driven filtering and control”. In: *IEEE Trans. Automat. Contr.* 62 (4 Apr. 2017), pp. 1972–1978. issn: 1558-2523. doi: 10.1109/TAC.2016.2591178.

C.15. I. Markovsky and G. Mercère. “Subspace identification with constraints on the impulse response”. In: *Int. J. Contr.* 90 (8 2017), pp. 1728–1735. doi: 10.1080/00207179.2016.1219922.

C.16. K. Usevich and I. Markovsky. “Variable projection methods for approximate (greatest) common divisor computations”. In: *Theoretical Computer Science* 681 (2017), pp. 176–198. doi: 10.1016/j.tcs.2017.03.028.

C.17. I. Markovsky. “On the most powerful unfalsified model for data with missing values”. In: *Systems & Control Lett.* 95 (2016), pp. 53–61. doi: 10.1016/j.sysconle.2015.12.012.

C.18. K. Usevich and I. Markovsky. “Adjusted least squares fitting of algebraic hypersurfaces”. In: *Linear Algebra Appl.* 502 (2016), pp. 243–274. doi: 10.1016/j.laa.2015.07.023.

C.19. I. Markovsky. “An application of system identification in metrology”. In: *Control Eng. Practice* 43 (2015), pp. 85–93. doi: 10.1016/j.conengprac.2015.07.001.

C.20. I. Markovsky. “Comparison of adaptive and model-free methods for dynamic measurement”. In: *IEEE Signal Proc. Lett.* 22.8 (2015), pp. 1094–1097. doi: 10.1109/LSP.2014.2388369.

C.21. I. Markovsky and R. Pintelon. “Identification of linear time-invariant systems from multiple experiments”. In: *IEEE Trans. Signal Process.* 63.13 (2015), pp. 3549–3554. doi: 10.1109/TSP.2015.2428218.

C.22. M. Ishteva, K. Usevich, and I. Markovsky. “Factorization approach to structured low-rank approximation with applications”. In: *SIAM J. Matrix Anal. Appl.* 35.3 (2014), pp. 1180–1204. doi: 10.1137/130931655.

C.23. I. Markovsky. “Recent progress on variable projection methods for structured low-rank approximation”. In: *Signal Processing* 96PB (2014), pp. 406–419. doi: 10.1016/j.sigpro.2013.09.021.

C.24. I. Markovsky, J. Goos, K. Usevich, and R. Pintelon. “Realization and identification of autonomous linear periodically time-varying systems”. In: *Automatica* 50 (2014), pp. 1632–1640. doi: 10.1016/j.automatica.2014.04.003.

C.25. I. Markovsky and K. Usevich. “Software for weighted structured low-rank approximation”. In: *J. Comput. Appl. Math.* 256 (2014), pp. 278–292. doi: 10.1016/j.cam.2013.07.048.

C.26. S. Rhode, K. Usevich, I. Markovsky, and F. Gauterin. “A Recursive Restricted Total Least-squares Algorithm”. In: *IEEE Trans. Signal Process.* 62.21 (2014), pp. 5652–5662. doi: 10.1109/TSP.2014.2350959.

C.27. K. Usevich and I. Markovsky. “Optimization on a Grassmann manifold with application to system identification”. In: *Automatica* 50 (2014), pp. 1656–1662. doi: 10.1016/j.automatica.2014.04.010.

C.28. K. Usevich and I. Markovsky. “Variable projection for affinely structured low-rank approximation in weighted 2-norms”. In: *J. Comput. Appl. Math.* 272 (2014), pp. 430–448. doi: 10.1016/j.cam.2013.04.034.

C.29. I. Markovsky. “A software package for system identification in the behavioral setting”. In: *Control Eng. Practice* 21.10 (2013), pp. 1422–1436. doi: 10.1016/j.conengprac.2013.06.010.

C.30. I. Markovsky and K. Usevich. “Structured low-rank approximation with missing data”. In: *SIAM J. Matrix Anal. Appl.* 34.2 (2013), pp. 814–830. doi: 10.1137/120883050.

C.31. F. Le, I. Markovsky, C. Freeman, and E. Rogers. “Recursive identification of Hammerstein systems with application to electrically stimulated muscle”. In: *Control Eng. Practice* 20.4 (2012), pp. 386–396. doi: 10.1016/j.conengprac.2011.08.001.

C.32. I. Markovsky. “On the complex least squares problem with constrained phase”. In: *SIAM J. Matrix Anal. Appl.* 32.3 (2011), pp. 987–992. doi: 10.1137/110826497.

C.33. F. Le, I. Markovsky, C. Freeman, and E. Rogers. “Identification of electrically stimulated muscle models of stroke patients”. In: *Control Eng. Practice* 18.4 (2010), pp. 396–407. doi: 10.1016/j.conengprac.2009.12.007.

C.34. I. Markovsky. “Bibliography on total least squares and related methods”. In: *Statistics and Its Interface* 3 (2010), pp. 329–334.

C.35. I. Markovsky. “Closed-loop data-driven simulation”. In: *Int. J. Contr.* 83.10 (2010), pp. 2134–2139. doi: 10.1080/00207179.2010.508093.

C.36. I. Markovsky, D. Sima, and S. Van Huffel. “Total least squares methods”. In: *Wiley Interdisciplinary Reviews: Comput. Stat.* 2.2 (2010), pp. 212–217. doi: 10.1002/wics.65.

C.37. I. Markovsky and S. Mahmoodi. “Least-squares contour alignment”. In: *IEEE Signal Proc. Letters* 16.1 (2009), pp. 41–44. doi: 10.1109/LSP.2008.2008588.

C.38. I. Markovsky. “Structured low-rank approximation and its applications”. In: *Automatica* 44.4 (2008), pp. 891–909. doi: 10.1016/j.automatica.2007.09.011.

C.39. I. Markovsky and M. Niranjan. “Approximate low-rank factorization with structured factors”. In: *Comput. Statist. Data Anal.* 54 (2008), pp. 3411–3420. doi: 10.1016/j.csda.2009.06.003.

C.40. I. Markovsky and P. Rapisarda. “Data-driven simulation and control”. In: *Int. J. Contr.* 81.12 (2008), pp. 1946–1959. doi: 10.1080/00207170801942170.

C.41. A. Kukush, I. Markovsky, and S. Van Huffel. “Estimation in a linear multivariate measurement error model with a change point in the data”. In: *Comput. Statist. Data Anal.* 52.2 (2007), pp. 1167–1182. doi: 10.1016/j.csda.2007.06.010.

C.42. I. Markovsky and S. Van Huffel. “Left vs right representations for solving weighted low rank approximation problems”. In: *Linear Algebra Appl.* 422 (2007), pp. 540–552. doi: 10.1016/j.laa.2006.11.012.

C.43. I. Markovsky and S. Van Huffel. “Overview of total least squares methods”. In: *Signal Processing* 87 (2007), pp. 2283–2302. doi: 10.1016/j.sigpro.2007.04.004.

C.44. M. Schuermans, I. Markovsky, and S. Van Huffel. “An adapted version of the element-wise weighted TLS method for applications in chemometrics”. In: *Chemometrics and Intelligent Laboratory Systems* 85.1 (2007), pp. 40–46. doi: 10.1016/j.chemolab.2006.04.003.

C.45. S. Shklyar, A. Kukush, I. Markovsky, and S. Van Huffel. “On the conic section fitting problem”. In: *Journal of Multivariate Analysis* 98 (2007), pp. 588–624. doi: 10.1016/j.jmva.2005.12.003.

C.46. S. Van Huffel, I. Markovsky, R. J. Vaccaro, and T. Söderström. “Guest editorial: Total least squares and errors-in-variables modeling”. In: *Signal Processing* 87.10 (Oct. 2007), pp. 2281–2282.

C.47. A. Kukush, I. Markovsky, and S. Van Huffel. “Consistency of the structured total least squares estimator in a multivariate errors-in-variables model”. In: *J. Statist. Plann. Inference* 133.2 (2005), pp. 315–358. doi: 10.1016/j.jspi.2003.12.020.

C.48. I. Markovsky and B. De Moor. “Linear dynamic filtering with noisy input and output”. In: *Automatica* 41.1 (2005), pp. 167–171. doi: 10.1016/j.automatica.2004.08.014.

C.49. I. Markovsky, M. Rastello, A. Premoli, A. Kukush, and S. Van Huffel. “The element-wise weighted total least squares problem”. In: *Comput. Statist. Data Anal.* 50.1 (2005), pp. 181–209. doi: 10.1016/j.csda.2004.07.014.

C.50. I. Markovsky and S. Van Huffel. “High-performance numerical algorithms and software for structured total least squares”. In: *J. Comput. Appl. Math.* 180.2 (2005), pp. 311–331. doi: 10.1016/j.cam.2004.11.003.

C.51. I. Markovsky, S. Van Huffel, and R. Pintelon. “Block-Toeplitz/Hankel structured total least squares”. In: *SIAM J. Matrix Anal. Appl.* 26.4 (2005), pp. 1083–1099. doi: 10.1137/S0895479803434902.

C.52. I. Markovsky, J. C. Willems, P. Rapisarda, and B. De Moor. “Algorithms for deterministic balanced subspace identification”. In: *Automatica* 41.5 (2005), pp. 755–766. doi: 10.1016/j.automatica.2004.10.007.

C.53. I. Markovsky, J. C. Willems, S. Van Huffel, B. De Moor, and R. Pintelon. “Application of structured total least squares for system identification and model reduction”. In: *IEEE Trans. Automat. Contr.* 50.10 (2005), pp. 1490–1500. doi: 10.1109/TAC.2005.856643.

C.54. M. Schuermans, I. Markovsky, P. Wentzell, and S. Van Huffel. “On the equivalence between total least squares and maximum likelihood PCA”. In: *Analytica Chimica Acta* 544.1–2 (2005), pp. 254–267. doi: 10.1016/j.aca.2004.12.059.

C.55. J. C. Willems, P. Rapisarda, I. Markovsky, and B. De Moor. “A note on persistency of excitation”. In: *Systems & Control Lett.* 54.4 (2005), pp. 325–329. doi: 10.1016/j.sysconle.2004.09.003.

C.56. A. Kukush, I. Markovsky, and S. Van Huffel. “Consistent estimation in an implicit quadratic measurement error model”. In: *Comput. Statist. Data Anal.* 47.1 (2004), pp. 123–147. doi: 10.1016/j.csda.2003.10.022.

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