Rodrigo A. González

Control Systems Technology
Department of Mechanical Engineering
Eindhoven University of Technology, the Netherlands

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Personal Information

Full name: Rodrigo Alejandro González Vidal Date of birth: 24th of September of 1992

Professional Degree: Ingeniero Civil Electrónico (Electronics Engineer)

Education

KTH Royal Institute of Technology

Stockholm, Sweden

Oct. 2017 - May 2022

- Ph.D. in Electrical Engineering
 - Title: Continuous-time System Identification: Refined Instrumental Variables and Sampling Assumptions.
 - Supervisor: Prof. Cristian R. Rojas
 - Opponent and Committee: Prof. Marion Gilson (Université de Lorraine, France), Dr. ir. John Lataire (VUB, Belgium), Prof. Tomas McKelvey (Chalmers, Sweden), Assoc. Prof. Roland Toth (TU Eindhoven, the Netherlands).

KTH Royal Institute of Technology

Stockholm, Sweden

Licentiate of Electrical Engineering

Oct. 2017 - June 2020

- Title: Consistency and Efficiency in Continuous-time System Identification
- Supervisor: Prof. Cristian R. Rojas.
- Opponent: Prof. Hugues Garnier (Université de Lorraine, Nancy, France)

Universidad Técnica Federico Santa María

Valparaíso, Chile

Master of Science of Electronic Engineering (Major: Automatic Control)

Mar. 2015 - Nov. 2016

- Title: Imposition of Causality and Passivity in Spectral Analysis (in Spanish).
- Supervisor: Prof. Ricardo A. Rojas
- Committee: Ph.D. Ricardo A. Rojas (UTFSM, Chile), Ph.D. Cristian R. Rojas (KTH, Sweden), Ph.Dc.
 Patricio E. Valenzuela (KTH, Sweden), Ph.D. Daniel Sbárbaro (U. Concepción, Chile)

Universidad Técnica Federico Santa María

Valparaíso, Chile

Electronics Engineering Degree (6-year degree)

Mar. 2011 - Nov. 2016

- Supervisor: Prof. Ricardo A. Rojas
- GPA: 92% (Maximum: 100%). Ranking: 1st out of 70 students

Research Experience

Postdoctoral researcher

Eindhoven, the Netherlands

Department of Mechanical Engineering, TU/e

June 15th, 2022 -

- Working with Prof. Tom Oomen's group, as part of the Control Systems Technology Section.

Visiting Researcher

Valparaíso, Chile Dec. 2022 - Jan. 2023

Department of Electronics, UTFSM

- 4-week research visit to the group of Prof. J. C. Agüero.

- Funded by the Chilean National Agency for Research and Development (ANID), grant ANID-FONDECYT 1211630.

Ph.D. student Stockholm, Sweden

Division of Decision and Control Systems, KTH

Oct. 2017 - May 2022

- Under the supervision of Prof. Cristian R. Rojas.

Visiting Researcher

Newcastle, NSW, Australia

School of Electrical Engineering and Computing, University of Newcastle

Nov. 2019 - Dec. 2019

- 5-week research visit to the group of Assoc. Prof. James Welsh

- Funded by the Complex Dynamic Systems and Control (CDSC) Scholarship.

Reviewer

IEEE-IFAC 2017 -

- Reviewer for IFAC Automatica Journal, Elsevier Signal Processing Journal, IEEE Transactions on Automatic Control, International Journal of Control, IEEE Control Systems Letters, IFAC World Congress, IFAC Symposium on System Identification, American Control Conference (ACC), IEEE Conference on Control Technology and Applications (CCTA).

Research Assistant Valparaíso, Chile

Department of Electronics, UTFSM

Feb. 2017 - Sept. 2017

- Hired by Project FONDECYT 1161241, 'Optimal estimation and control over communication channels subject to data loss'
- Under the supervision of Prof. Francisco Vargas
- Output: One conference paper (ECC2018), two journal papers (TAC and L-CSS).

Stockholm, Sweden

Division of Decision and Control Systems, KTH

Mar. 2016

- 2-week research visit to the System Identification Group of KTH, invited by Prof. Cristian Rojas.

Research Intern Berlin, Germany

Control Systems Group, TU Berlin

Jan. 2016 - Feb. 2016

- 8-week internship
- Funded by CONICYT's 'Scholarship for short internships abroad'.

Teaching and Supervision Experience

Teaching Assistant TU/e, the Netherlands

4CM40 'Physical and Data-driven Modelling' (Masters Course)

Spring 2023

Teaching Assistant EL2820 'Modelling of Dynamical Systems' (Masters Course) KTH, Sweden

Autumns 2018-2021

Supervisor of Bachelor Theses projects

KTH. Sweden

Bachelor Thesis Course, Electrical Engineering Program

Springs 2018-2020

- Project 2020: 'Stock Market Prediction with Deep Learning' by Kiar Fatah and Tariq Nazar.
- Project 2019: 'Evaluating LASSO and ARIMA algorithms for financial forecasting', by Oskar Erlandsson and Andrej Wilczek.

 Project 2018: 'Evaluating different algorithms for detecting change-points in time series', by Henrik Eriksson and Victor Löfgren.

Supervisor of MSc. Theses

KTH, Sweden

Master Program in System, Control and Robotics

2018-2021

- Thesis 2021: 'Current Control and Modelling of an Inspiration Valve' by Astrid Lindstedt (with Getinge).
- Thesis 2021: 'System Identification of continuous-time systems with quantized output data using indirect inference' by Frida Persson.
- Thesis 2020: 'Inertial Domain Transfer using Generative Adversarial Networks' by Saieshwar Radhakrishnan (with Scania)
- Thesis 2020: 'Adaptive Model Predictive Control for Reference Tracking Vehicle Motion' by Sven Grenholm (with Transrail)
- Thesis 2019: 'Online maximum capacity estimation of a propulsion battery on heavy duty vehicles', by Nikolaos Karavalakis (with Scania)
- Thesis 2018: 'Hydraulic Closed Loop Control', by Maria Elfving (with Volvo)

•	Teaching Assistant <i>ELO-370 'Automatic Control II' (Digital Control)</i>	Department of Electronics, UTFSM, Chile 2 nd Semester 2016
•	Teaching Assistant <i>ELO-104 'Linear Systems Analysis' (four times)</i>	Department of Electronics, UTFSM, Chile 2015 - 2016
•	Teaching Assistant <i>MAT-024 'Multivariable Integration and PDEs'</i>	Department of Mathematics, UTFSM, Chile 2 nd Semester 2015
•	Teaching Assistant <i>MAT-023 'Multivariable Differential Calculus and ODEs'</i>	Department of Mathematics, UTFSM, Chile <i>1st Semester 2014</i>
•	Teaching Assistant FIS-120 'Electromagnetism'	Department of Physics, UTFSM, Chile 2 nd Semester 2013
•	Teaching Assistant <i>MAT-021 'Algebra and Elementary Calculus'</i>	Department of Mathematics, UTFSM, Chile <i>1st Semester 2013</i>
•	Teaching Assistant <i>MAT-022 'Linear Algebra and Single Variable Integration' (t</i>	Department of Mathematics, UTFSM, Chile wice) 2 nd Semester 2012-2013

Other working experience

Volunteer in the organizing crew of SYSID'18

Stockholm, Sweden

KTH Royal Institute of Technology

2018

 In charge of solving technical issues and support during the IFAC Symposium on System Identification (SYSID'18), held in Stockholm.

Report Assistant Valparaíso, Chile

Department of Electronics, UTFSM

2016

- Report assistant and member of the committee of the accreditation process of the Master of Science degree in Electronic Engineering.
- After 1 year of work, we obtained 2 extra years of accreditation of the program (from 6 to 8).

Vicepresident of the Student Union

Valparaíso, Chile

 Vicepresident of the association of all ∼650 students of Electronic and Telematic Engineering of the UTFSM. The position lasts one year.

Summer intern Ventanas, Chile

Codelco, Ventanas Division

Jan. 2015 - March. 2015

- Summer intern for 8 weeks in the Refinement section of Codelco (National Corporation of Copper).

Summer intern Santiago, Chile

Honeywell Chile S.A.

Jan. 2014 - March. 2014

- Summer intern for 8 weeks in Honeywell Chile S.A., Advanced Process Control Area.

PSU practice test corrector *Admission team*, *UTFSM*

Valparaíso, Chile

2011 - 2016

- In charge of the validation and listing of format and mathematical errors of the PSU (National University Selection Test) practice tests of the UTFSM.
- Over 30 practice exams validated.

Courses

• Ph.D. Courses taken at KTH, Sweden:

- FJL3380, Theoretical Foundations of Machine Learning (Spring 2019)
- FAK3127, The Sustainable Scientist (Spring 2019)
- FEL3202, Data Driven Modeling Extended Course (Spring 2019)
- FEL3370, Mathematical Method in Signals, Systems and Control (Spring 2019)
- FAK3014, Theory and Methodology of Science (Spring 2019)
- FEM3200, Optimal Filtering (Autumn 2018)
- FEM3220, Matrix Algebra (Spring 2018)
- FDS3103, Introduction to Scientific Writing (Spring 2018)
- FSF3862, Nonlinear Systems, Analysis and Control (Spring 2018)
- FLH3000, Basic Communication and Teaching (Spring 2018)
- FEL3210, Multivariable Feedback Control Systems (Autumn 2017)
- FEF3301, Computational Game Theory (Autumn 2017)

• MSc./Ph.D. Courses taken at UTFSM, Chile:

- MAT235, Functional Analysis (attended lectures Semester 2017-1)
- MAT379, Optimization and Control (attended lectures Semester 2017-1)
- MAT263, Probability Theory and Stochastic Processes (attended lectures Semester 2016-1)
- MAT226, Measure Theory (attended lectures Semester 2015-2)
- MAT235, Complex Variables (Semester 2015-2)
- IPD476, Multivariable Control (Semester 2015-2)
- MAT225, Real Analysis (Semester 2015-1)
- IPD469, Models for Control (Semester 2015-1)
- IPD462, Advanced Design of Control Systems (Semester 2015-1)
- IPD468, System Dynamics (Semester 2014-2)

- IPD460, Information Theory (Semester 2014-2)
- IPD431, Probability and Random Processes (Semester 2014-1)
- IPD410, Mathematical Methods in Automatic Control (Semester 2013-2)

• Coursera courses taken (with certificate):

- Number Theory and Cryptography (UC San Diego)
- The Science of Well-Being (Yale)
- Psychological First Aid (John Hopkins University)
- Learning How to Learn: Powerful mental tools to help you master tough subjects (McMaster University)
- Write Professional Emails in English (Georgia Institute of Technology)
- Work Smarter, Not Harder: Time Management for Personal & Professional Productivity (UCI Division of Continuing Education)

Merits and Awards

Ericsson

Recipient of the 'Esfuerzo es Progreso' award UTFSM

Valparaíso, Chile

2019

- Testamentary donation/award given to the best Electronic Engineering student of UTFSM graduated in 2016.
- Recipient of Complex Dynamic Systems and Control (CDSC) Scholarship

 University of Newcastle, Australia

Newcastle, Australia

2019

- Research scholarship of AUD \$5000 for visiting the University of Newcastle during November 2019.

Recipient of grant by The Ericsson Research Foundation

Stockholm, Sweden

2019

 Grant of 10000 SEK to attend the 2019 Summer School of High Dimensional Probability and Algorithms, held in Paris, France, July 1-5th.

Recipient of the 'Marcos Orrego Puelma' award

Santiago, Chile

Institute of Engineers of Chile

2017

2016

2016

- Award given to the best Engineering student of UTFSM graduated in 2016 (among \sim 1000 students).
- Recipient of the 'Mejor titulado Ing. Civil Electrónica promoción 2016' award School of Engineers of Chile

Valparaíso, Chile

2017

 Distinction given to the best Electronic Engineer of UTFSM graduated in 2016, in recognition of his academic performance and his conditions of leadership and participation.

Recipient of the Distinción Académica 'Federico Santa María' UTFSM

Valparaíso, Chile

- Award given to the best student of Electronics Engineering graduated in 2016.

Outstanding student of Master studies in Electronic Engineering $\it UTFSM$

Valparaíso, Chile

- Award given to the best student of Master of Science of Electronic Engineering graduated in 2016.

Recipient of the CONICYT 'Scholarship for Master studies in Chile'

Santiago, Chile

CONICYT

2015-2016

- National scholarship given to approximately 250 students in Chile per year to economically support their MSc. studies in a Chilean university.
- Achieved the third highest score in the scholarship selection process (out of more than 2500 applicants).

Recipient of the CONICYT 'Scholarship for short internships abroad' CONICYT

Santiago, Chile

2015

 National scholarship given to approximately 60 students in Chile per year to afford a short internship in a university abroad.

1st place in the Honor list

Valparaíso, Chile

UTFSM

2014 and 2015

- Honor given to the student with the best academical performance of all the University (among \sim 10000 students).

2nd place in the Honor list

Valparaíso, Chile

UTFSM

2013 and 2016

- Honor given to the student with the second best academical performance of all the University (among \sim 10000 students).

Recipient of the Academic Merit of the Electronics Department Award

Valparaíso, Chile

Department of Electronics, UTFSM

2012-2017

- Award given to all the students of the Electronics Department with average academic qualifications of over 80 out of 100 (95th percentile approximately).
- Award won six consecutive times (all the times possible).

Recipient of the 'Premio al Mérito Académico UTFSM' UTFSM

Valparaíso, Chile

2012-2016

- Award given to the two students with highest academic qualifications of all their generation in the University (around 1000 students per generation).
- Award won five consecutive times (all the times possible).

'Puntaje Nacional' Scholarship

Valparaíso, Chile

UTFSM

2011-2016

- Full undergraduate and postgraduate scholarship given to the student with perfect score in any PSU test (National University Selection Test) of 2010.

Highest PSU score of the UTFSM in 2011

Valparaíso, Chile

UTFSM

2011

 Honor given to the student with highest average PSU (National University Selection Test) score who entered the UTFSM in 2011.

Perfect PSU score in Mathematics

Valparaíso, Chile

Ministry of Education of Chile

2010

- Honor given to the student with perfect score in the PSU (National University Selection Test) of Mathematics of 2010.
- Only 450 students achieved this score in 2010 (out of more than 250000).

Skills

- Computer Skills: MATLAB (advanced), LATEX (advanced), Python (Intermediate), HTML (Basic).
- Languages: Spanish (native), English (fluent).

• Hold a Chilean driver's license (B).

Publications

Journal papers

- [J10] Angel L. Cedeño, Rodrigo A. González, Boris I. Godoy, Rodrigo Carvajal and Juan C. Agüero. "On filtering and smoothing algorithms for linear state-space models having quantized output data". In *Mathematics*, 11(6): 1327, 2023.
- [J9] Siqi Pan, James S. Welsh, **Rodrigo A. González** and Cristian R. Rojas. "Consistency Analysis and Bias Elimination of the Instrumental Variable Based State Variable Filter Method". *Automatica*, Article 110511, 2022.
- [J8] **Rodrigo A. González**, Cristian R. Rojas, Siqi Pan and James S. Welsh. "Refined instrumental variable methods for unstable continuous-time systems in closed-loop". *International Journal of Control*, 2022.
- [J7] **Rodrigo A. González**, Cristian R. Rojas, Siqi Pan and James S. Welsh. "Theoretical and practical aspects of the convergence of the SRIVC estimator for over-parameterized models". *Automatica*, Article 110355, 2022.
- [J6] **Rodrigo A. González**, Cristian R. Rojas, Siqi Pan and James S. Welsh. "Consistent identification of continuous-time systems under multisine input signal excitation". *Automatica*, Article 109859, 2021.
- [J5] Siqi Pan, James S. Welsh, **Rodrigo A. González** and Cristian R. Rojas. "Efficiency Analysis of the Simplified Refined Instrumental Variable Method for Continuous-time Systems". *Automatica*, Article 109196, 2020.
- [J4] Siqi Pan, **Rodrigo A. González**, James S. Welsh and Cristian R. Rojas. "Consistency Analysis of the Simplified Refined Instrumental Variable Method for Continuous-time Systems". *Automatica*, Article 108767, 2020.
- [J3] Francisco J. Vargas and **Rodrigo A. González**. "On the existence of a stabilizing solution of Modified Algebraic Riccati Equations in terms of standard Algebraic Riccati Equations and Linear Matrix Inequalities". In *IEEE Control Systems Letters*, 4(1): 91-96, 2019.
- [J2] **Rodrigo A. González**, Francisco J. Vargas and Jie Chen. "Necessary and sufficient conditions for mean square stabilization over MIMO SNR-Constrained channels with colored and spatially correlated additive noises". In *IEEE Transactions on Automatic Control*, 64(11): 4825-4832. 2019.
- [J1] **Rodrigo A. González**, Patricio E. Valenzuela, Cristian R. Rojas and Ricardo A. Rojas. "Optimal enforcement of causality in non-parametric transfer function estimation". In *IEEE Control Systems Letters*, 1(2): 268-273, 2017.

Conference papers

- [C12] Augustus Elton, Rodrigo A. González, James S. Welsh, Tom Oomen and Cristian R. Rojas. "Blind non-parametric estimation of SISO continuous-time systems". In *Proceedings of the IFAC World Congress* 2023 (IFAC WC 2023) (accepted for publication), 2023.
- [C11] Rodrigo A. González, Cristian R. Rojas, Siqi Pan and James S. Welsh. "Parsimonious identification of continuous-time Systems: A block-coordinate descent approach". In *Proceedings of the IFAC World Congress* 2023 (IFAC WC 2023) (accepted for publication), 2023.
- [C10] **Rodrigo A. González**, Koen Tiels and Tom Oomen. "Identifying Lebesgue-sampled continuous-time impulse response models: A kernel-based approach". In *Proceedings of the IFAC World Congress 2023 (IFAC WC 2023)* (accepted for publication), 2023.

- [C9] **Rodrigo A. González**, Angel L. Cedeño, María Coronel, Juan C. Agüero and Cristian R. Rojas. "An EM algorithm for Lebesgue-sampled state-space continuous-time system identification". In *Proceedings of the IFAC World Congress 2023 (IFAC WC 2023)* (accepted for publication), 2023.
- [C8] Rodrigo A. González, Cristian R. Rojas, Siqi Pan and James S. Welsh. "The SRIVC algorithm for continuous' time system identification with arbitrary input excitation in open and closed loop". In Proceedings of the 60th IEEE Conference on Decision and Control (CDC'21), pages 3004-3009, 2021.
- [C7] **Rodrigo A. González**, Cristian R. Rojas and Håkan Hjalmarsson. "Non-causal regularized least-squares for continuous-time system identification with band-limited input excitations". In *Proceedings of the 60th IEEE Conference on Decision and Control (CDC'21)*, pages 114-119, 2021.
- [C6] **Rodrigo A. González** and Cristian R. Rojas. "A finite-sample deviation bound for stable autoregressive processes". In *Proceedings of the 2nd Conference on Learning for Dynamics and Control (L4DC)*, Berkeley, USA, pages 191-200, 2020.
- [C5] **Rodrigo A. González**, James S. Welsh and Cristian R. Rojas. "Enforcing stability through ellipsoidal inner approximations in the indirect approach for continuous-time system identification". In *Proceedings of the 21st IFAC World Congress (IFAC'2020)*, Berlin, Germany, pages 566-571, 2020.
- [C4] **Rodrigo A. González** and Cristian R. Rojas. "Finite sample deviation and variance bounds for first order autoregressive processes". In *Proceedings of the 45th International Conference on Acoustics, Speech, and Signal Processing (ICASSP'20)*, Barcelona, Spain, pages 5380-5384, 2020.
- [C3] **Rodrigo A. González**, James S. Welsh and Cristian R. Rojas. "An asymptotically optimal indirect approach to continuous-time system identification". In *Proceedings of the 57th IEEE Conference on Decision and Control (CDC'18)*, Miami Beach, FL, USA, pages 638-643, 2018.
- [C2] Rodrigo A. González and Cristian R. Rojas. "A fully Bayesian approach to kernel-based regularization for impulse response estimation". In *Proceedings of the 18th IFAC Symposium on System Identification* (SYSID'18), Stockholm, Sweden, pages 186-191, 2018.
- [C1] **Rodrigo A. González**, Francisco J. Vargas and Jie Chen. "Stabilization of MIMO systems over additive correlated noise channels subject to multiple SNR-constraints". In *Proceedings of the 16th European Control Conference (ECC'18)*, Limassol, Cyprus, pages 1493-1498, 2018.

Submitted Journal papers

- [SJ5] Augustus Elton, **Rodrigo A. González**, James S. Welsh, Cristian R. Rojas and Minyue Fu. "Parametric Continuous-Time Blind System Identification". *IEEE Control Systems Letters* (submitted for publication), 2023.
- [SJ4] **Rodrigo A. González**, Koen Tiels and Tom Oomen. "Kernel-based identification using Lebesgue-sampled data". *Automatica* (submitted for publication), 2023.
- [SJ3] **Rodrigo A. González**, Cristian R. Rojas, Siqi Pan and James S. Welsh. "On the relation between discrete and continuous-time refined instrumental variable methods". *IEEE Control Systems Letters* (submitted for publication), 2023.
- [SJ2] Angel L. Cedeño, **Rodrigo A. González**, Rodrigo Carvajal and Juan C. Agüero. "Identification of Wiener state-space models utilizing Gaussian sum smoothing". *Automatica* (submitted for publication), 2023.
- [SJ1] **Rodrigo A. González**, Siqi Pan, Cristian R. Rojas and James S. Welsh. "Consistency analysis of refined instrumental variable methods for continuous-time system identification in closed-loop". *Automatica* (submitted for publication), 2022.

Theses

- [T3] **Rodrigo A. González**, *Continuous-time System Identification: Refined Instrumental Variables and Sampling Assumptions*. Ph.D. Thesis, KTH Royal Institute of Technology, May 2022. Supervisor: Prof. Cristian R. Rojas.
- [T2] **Rodrigo A. González**, Consistency and efficiency in continuous-time system identification. Licentiate of Engineering Thesis, KTH Royal Institute of Technology, June 2020. Supervisor: Prof. Cristian R. Rojas.
- [T1] **Rodrigo A. González**, *Enforcement of Causality and Passivity in Spectral Analysis* (in Spanish). Master's Thesis, Universidad Técnica Federico Santa María, Valparaíso, Chile, November 2016. Supervisors: Prof. Ricardo A. Rojas, Cristian R. Rojas and Patricio E. Valenzuela.

Books

[B1] Rodrigo A. González, Exercise Compendium of Linear Systems Analysis (in Spanish). July 2019.

Others

- [P8] **Rodrigo A. González**, Koen Tiels and Tom Oomen. "Non-parametric continuous-time system identification with Lebesgue-sampled output measurements". Presentation at the 42nd Benelux Meeting on Systems and Control, March 2023, Elspeet, The Netherlands.
- [P7] **Rodrigo A. González**, Koen Tiels and Tom Oomen. "Non-parametric Identification of Lebesgue-sampled Continuous-time Systems" (in Spanish). Presentation at the first Symposium on Identification, Control and Applications at UTFSM, January 2023, Valparaíso, Chile.
- [P6] Rodrigo A. González, Angel L. Cedeño, María Coronel, Juan C. Agüero and Cristian R. Rojas. "Identification of Continuous-Time Systems Utilizing Lebesgue-Sampled Data". Poster at the 2022 Workshop of the European Research Network on System Identification (ERNSI), September 2022, Leuven, Belgium.
- [P5] **Rodrigo A. González**, Cristian R. Rojas and Håkan Hjalmarsson. "Non-causal regularized least-squares for continuous-time system identification with band-limited input excitations". Poster at the 2021 Workshop of the European Research Network on System Identification (ERNSI), September 2021, online.
- [P4] **Rodrigo A. González**, James S. Welsh and Cristian R. Rojas. *An asymptotically optimal indirect approach to continuous-time system identification*. Internal seminar at the University of Newcastle, December 2019, Newcastle, New South Wales, Australia.
- [P3] Rodrigo A. González, Siqi Pan, Cristian R. Rojas and James S. Welsh. Consistency of the Simplified Refined Instrumental Variable Method for Continuous-time Systems: Analysis and Design. Poster at the 2019 Workshop of the European Research Network on System Identification (ERNSI), September 2019, Maastricht, Netherlands.
- [P2] **Rodrigo A. González**, James S. Welsh and Cristian R. Rojas. *An asymptotically optimal indirect approach to continuous-time system identification*. Poster at the 2018 Workshop of the European Research Network on System Identification (ERNSI), September 2018, Cambridge, U.K.
- [P1] **Rodrigo A. González** and Cristian R. Rojas. *An asymptotically optimal indirect approach to continuous-time system identification*. Presentation at the 2018 Swedish Control Conference (Reglermötet), June 2018, Stockholm, Sweden.

Interests

• Sports: Running, Soccer, Basketball.

• Music: Guitar (acoustic, electric), Bass (fretted and fretless), Keyboards.

• Other interests: Chess, reading.