Phd in Statistics · Edinburgh, Scotland · **thiago.oliveira@ed.ac.uk** · Phone: +44 7474 338884

Thiago de Paula Oliveira | CV

- Statistical computing: `R`, `Shiny`, `Bash`, `Maple`, `SageMath`, `C++`, `blupf90`
- Computational programs: LaTeX, Markdown, Office, GitHub, Inkscape
- Operational systems: Linux, Mac, Windows
- Languages: Portuguese (native), English
- Research web pages: ORCID, Plubons, Personal Webpage

General Information

- Work Address: The University of Edinburgh, Easter Bush Campus, Midlothian EH25 9RG, Scotland
- Tel: +44 7474 338884
- E-mail Address: thiago.oliveira@ed.ac.uk

- Date of Birth 01 February 1985, Tatuí, Brazil
- Nationality: Brazilian
- Marital Status: Married

Summary

I hold a PhD in Statistics from the University of São Paulo, Brazil, and have at least eight years of experience in experimental statistics, statistical modelling, and concordance analysis. As a PhD candidate, I was a visiting Scholar at the National University of Ireland in 2016, working with statistical modelling for agricultural data. Besides, I was a lecturer in the Department of Exact Sciences at ESALQ/University of São Paulo, Piracicaba, São Paulo, Brazil, from 2017 to 2019.

I worked as a Researcher Biostatistician from 2019 to 2020 at Insight Centre for Data Analytics in partnership with Orreco, School of Mathematics, Statistics, Applied Mathematics, and NUI Galway to develop statistical methods applied to athlete performance and predictive models for COVID-19. I developed statistical methods in longitudinal concordance correlation, multilevel or hierarchical model, generalized linear mixed-effects model, state-space models, experimental design, and longitudinal data.

As an enthusiast of the usage of dashboard apps to create an interactive data visualization, I believe that interactive applications are an easier way to create visual representations of large-scale data sets, allowing the user to explore the complex reality of the database or even handle multiple sets of data in a single visualization.

Recently, I was awarded a Marie Skodowska-Curie COFOUND Fellowship (Train@Ed) to work at The Roslin Institute - The University of Edinburgh, where I currently work on the development of statistical models applied to quantitative genetics and genomics of plant breeding in partnership with Limagrain.

Education

2014 – 2018 (4 years) PhD in Statistics — University of São Paulo – ESALQ/USP

- Title: Estimating the longitudinal concordance correlation through fixed effects and variance components of polynomial mixed-effects regression model
- Advisor: Dr. Silvio Sandoval Zocchi and Prof. John Hinde
- Department of Exact Sciences

2016 (3 months) — Visiting scholar – internship — NUIGalway

- Supervisor: Prof. John Hinde
- School of Mathematics, Statistics and Applied Mathematics
- Development of new methodology in Concordance Analysis

2012 – 2014 (2 years) — MSc in Statistics — University of São Paulo – ESALQ/USP

- Title: Mixed-effects models applied to hue peel color of papaya cv. Sunrise Solo measured by an scanner and colorimeter over time
- Advisor: Dr. Silvio Sandoval Zocchi
- Department of Exact Sciences

2007 – 2012 (5 years) — BSc in Agricultural Engineering — University of São Paulo – ESALQ/USP

- Title: Calibration of scanner methodology to evaluate 'Golden' papaya peel color.
- Advisor: Dr. Silvio Sandoval Zocchi
- Department of Exact Sciences

Professional experience

2020-Actual — Researcher Fellow — University of Edinburgh

- PI: Dr. Gregor Gorjanc
- Quantitative genetics and genomics of plant breeding
- The Roslin Institute

2020 (3 months) — Postdoc in Biostatistics — NUIGalway

- Supervisor: Prof. Dr. Carl Scarrott
- Early Detection of Secondary Waves of Covid-19 Infections
- School of Mathematics, Statistics & Applied Maths; and Insight Centre for Data Analytics

2020 (3 months) — Postdoc in Biostatistics — NUIGalway

- Supervisor: Prof. Dr. John Newell
- Aspire Academy research collaboration project
- School of Mathematics, Statistics & Applied Maths; and Insight Centre for Data Analytics

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2019 (8 months) — Postdoc in Biostatistics — NUIGalway

- Supervisor: Prof. Dr. John Newell
- Statistical modeling for optimizing athlete performance
- School of Mathematics, Statistics & Applied Maths; Orreco; and Insight Centre for Data Analytics

2018-2019 (10 months) — Postdoc in Statistics — University of São Paulo – ESALQ/USP

- Advisor: Prof. Dr. Clarice Garcia Borges Demétrio
- Title: Estimation of the longitudinal concordance correlation function: The `lcc` package
- Department of Exact Sciences

2017 – 2019 — Assistant Professor at University of São Paulo – ESALQ/USP (18 months)

Volunteer experience

2016 — Class tutor in Calculus at University of São Paulo – ESALQ/USP (5 months)

2015 — Class tutor in Statistics at University of São Paulo – ESALQ/USP (5 months)

Research experience

Development of cattle and plant breeding programmes

Generalized linear mixed-effects models (Classical and Bayesian)

Concordance analysis (Agreement, precision, and accuracy measures)

Bootstrap methods for confidence intervals (Non-parametric and parametric)

Experimental Designs (Complete and Incomplete Blocks, Latin Square, Full factorial, Fractional Factorial, Split-Plot, Central Composite, Nested designs)

Longitudinal data and Observational Studies

State space models (ARMA, ARIMA and Random Walk models)

Development of R packages, Dashboard Design, and Webpages (Github)

Publications

Table 1: Publications and indexes summary

Article	R Package	Abstract	Preprint	H-Index	Times Cited
9	2	12	1	6	82

Papers in Peer-Reviewed Journals

Article — Lara, L.A.d.C.; Pocrnic, I.; **Oliveira, T.d.P.**; Gaynor, C.; Gorjanc, G. Temporal and genomic analysis of additive genetic variance in breeding programmes, **Heredity**, 2021. DOI: 10.1038/s41437-021-00485-y

Article — **Oliveira, T.P.**; Buinvels, G; Pedlar, C.; Newell, J. Modelling menstrual cycle length in athletes using state-space models, **Scientific Reports**, 11, 2021. DOI: 10.1038/s41598-021-95960-1

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Article — **Oliveira, T.P.**; Moral, R.A. Global Short-Term Forecasting of Covid-19 Cases, **Scientific Reports**, 2021. DOI: https://doi.org/10.1038/s41598-021-87230-x

Article — **Oliveira, T.P.**; Moral, R. A.; Zocchi, S. S.; Demetrio, C. G. B; Hinde, J. lcc: an R package to estimate the concordance correlation, Pearson correlation, and accuracy over time. **PeerJ**. Accepted for publication in August of 2020. DOI: 10.7717/peerj.9850

Article — Kleina, H. T.; Kudlawiec, K.; Esteves, M. B.; Daibó, M.; **Oliveira, T.P.**; Maluta, N.; Lopes, J. S.; Mio, L. M. Association of leaf morphology, vector settling and feeding behavior with resistence of plum genotypes to leaf scald disease. **Entomologia Experimentalis et Applicata**. Accepted for publication in August of 2020. DOI: 10.1007/s10658-020-02104-8

Article — Popin, G. V.; Santos, A. K. B.; **Oliveira, T.P.**; Camargo, P. B.; Cerri, C. E. P.; Siqueira-Neto; M. Sugarcane straw management for bioenergy: effects of global warming on greenhouse gas emissions and soil carbon storage. **Mitigation and Adaptation Strategies for Global Change**, 2019. Link: https://doi.org/10.1007/s11027-019-09880-7

Article — Esteves, M. B.; Kleina, H. T.; Sales, T. M.; **Oliveira, T.P.**; Lara, I. A. R.; Almeida, R. P. P.; Coletta-Filho, H. D.; Lopes, J. R. S. Transmission efficiency of *Xylella fastidiosa* subsp. *pauca* sequence types by sharpshooter vectors after *in vitro* acquisition. **The American Phytopathological Society**, v. 109, no.2, 2019. Link: https://doi.org/10.1094/PHYTO-07-18-0254-FI

Article — **Oliveira, T.P.**; Hinde, J.; Zocchi, S. S. Longitudinal Concordance Correlation Function Based on Variance Components: An Application in Fruit Color Analysis. **Journal of Agricultural, Biological, and Environmental Statistics**, v. 23, p. 233-254, 2018. Link: https://doi.org/10.1007/s13253-018-0321-1

Article — **Oliveira, T.P.**; Zocchi, S. S. ; Jacomino, A. P. Measuring color hue in 'Sunrise Solo' papaya using a flatbed scanner. **Revista Brasileira de Fruticultura**, v. 39, p. e-911, 2017. Link: http://dx.doi.org/10.1590/0100-29452017911

Software

R package — Gorjanc, Gregor; Obsteter, Jana; **Oliveira, T.P. Partition/Decomposition of Breeding Values by Paths of Information**, R package version 0.9.3, 2022. See also https://github.com/AlphaGenes/AlphaPart/tree/version-0.9.3

R package — **Oliveira, T.P.**; Moral, R. A.; Hinde, J.; Zocchi, S. S.; Demetrio, C. G. B. **lcc: Longitudinal Concordance Correlation**, R package version 1.0.2, 2018. See also https://github.com/Prof-ThiagoOliveira/lcc

Preprints

Preprint — **Oliveira, T.d.P.**; Obšteter, J.; Pocrnic, I.; Heslot, N.; Gorjanc, G. A method for partitioning trends in genetic mean and variance to understand breeding practices, **BioRxiv**, 2022. DOI: https://doi.org/10.1101/2022.01.10.475603

Proceedings

Extended abstract — **Oliveira, T.d.P.**; Obšteter, J.; Pocrnic, I.; Gorjanc, G. A method for partitioning trends in genetic mean and variance to understand/improve breeding practices, **In: World Congress on Genetics Applied to Livestock and Production**

Extended abstract — **Oliveira, T.P.**; Moral, R.A.; Hinde, J.; Zocchi, S.S.; Demétrio, C.G.B. The longitudinal concordance correlation. **In: 34th International Workshop on Statistical Modelling**, 2019, Guimarães. Proceedings of the 34th International Workshop on Statistical Modelling, 2019. v. 2.

Abstract — Zocchi, S.S.; **Oliveira, T.P.** Propagação de Penicillium em laranja (Citrus cinensis): estimulando o aprendizado de cálculo. 1° Oficina para o desenvolvimento docente de 2017, "Novas abordagens de ensino - compartilhando experiências na ESALQ", 2017

Abstract — **Oliveira, T.P.**; Hinde, J.; Zocchi, S.S. Longitudinal Concordance correlation function based on variance components: an application in fruit color analysis. NUIG Statistics MiniSymposium, 2016.

Extended abstract — **Oliveira, T.P.**; Moral, R.A.; Hinde, J.; Demétrio, C.G.B.; Zocchi, S.S.; Zanardo, A.B.R.; Delalibera Jr., I. Generalized linear mixed models applied to overdispersed proportion data in a fungal occurrence study. **In: 30^{th} International Workshop on Statistical Modelling**, 2015, Linz. Proceedings of the 30^{th} International Workshop on Statistical Modelling, 2015. v. 2. p. 203-206.

Abstract — **Oliveira, T.P.**; Moral, R.A.; Hinde, J.; Demétrio, C.G.B.; Zocchi, S.S. Generalized linear mixed models: an application in fungal occurrence data. In: **60ª Reunião Anual da Região Brasileira da Sociedade Internacional de Biometria e 16° Simpósio de Estatística Aplicada à Experimentação Agronômica**, 2015, Presidente Prudente. Reunião Anual da Região Brasileira da Sociedade Internacional de Biometria, n. 60, Presidente Prudente, 2015. 172 p., 2015.

Abstract — **Oliveira, T.P.**; Zocchi, S.S. ; Ferreira, I. E.P. Mixed models for analysis of hue peel colour of papaya (Carica papaya L.) cv. Sunrise Solo, measured along time by means of a scanner and a colorimeter. In: XXVII International Biometric Conference, 2014, Florence, Italy. Proceedings of XXVII International Biometric Conference, 2014. v. 1.

Abstract — **Oliveira, T.P.**; Zocchi, S.S. Mixed models for analysis of hue peel color of papaya (Carica papaya L.) cv. 'Sunrise Solo', measured along time by means of a scanner and a colorimeter. I Workshop on Experimental Statistics e IV Encontro dos Alunos do PPG em Agronomia (Estatística e experimentação agrnômica), 2014.

Extended abstract — **Oliveira, T.P.**; Zocchi, S. S. . Análise de dados circulares com aplicação em tonalidade da cor de casca de mamão 'Sunrise Solo'. In: **58ª Reunião Anual da Região Brasileira da Sociedade Internacional de Biometria e 15° Simpósio de Estatística Aplicada à Esperimentação Agronômica**, 2013, Campina Grande. Anais..., 2013. p. 202.

Extended abstract — **Oliveira, T.P.**; Zocchi, S. S. Análise de dados circulares com aplicação em tonalidade da cor de casca de mamão 'Sunrise Solo'. In: **58ª Reunião Anual da Região Brasileira da Sociedade Internacional de Biometria e 15° Simpósio de Estatística Aplicada à Esperimentação Agronômica**, 2013, Campina Grande. Anais..., 2013. p. 202.

Abstract — **Oliveira, T.P.**; Zocchi, S. S. Modelos lineares de efeitos mistos: um estudo de caso. Encontro dos Alunos do Programa de Pós-Graduação em Estatística e e Experimentação Agronômica, 2013

Abstract — Camara, G. M. S.; **Oliveira, T.P.**; Navarro, B. L. ; Brigliadori, L. D. Crescimento e produtividade de soja em três arranjos espaciais. In: **VI Congresso Brasileiro de Soja**, 2012, Cuiabá-MT. Anais. Londrina-PR : Embrapa Soja, 2012. v. 1. p. 151-153.

Thesis

Thesis — **Oliveira, T.P.** Estimating the longitudinal concordance correlation through fixed effects and variance components of polynomial mixed-effects regression model. University of São Paulo, 2018

Thesis — **Oliveira, T.P.** Mixed-effects models applied to hue peel color of papaya cv. Sunrise Solo measured by an scanner and colorimeter over time. University of São Paulo, 2014

Masters and PhD Examiners

2019 — Nascimento, C.O.; Lara, I.A.R. Analysis of color peel of the papaya cv. Sunrise Solo through of the mixed linear regression model. Thesis (Masters Degree in Statistics) – University of São Paulo, Piracicaba, Brazil.

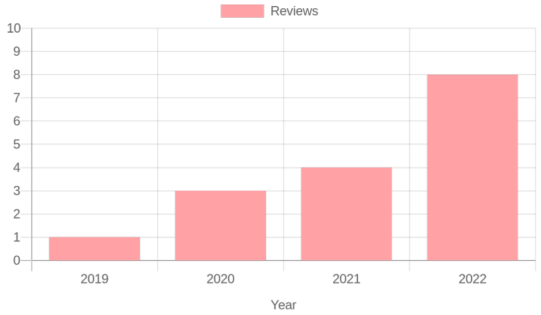
2022 — Silva, G.P.; Moral, R. A. Frame by frame completion probability of an American football pass. Thesis (Masters Degree in Statistics) – University of São Paulo, Piracicaba, Brazil.

Supervisor

2022 Das, Kishor. Statistical Approaches for Method Comparison Studies involving Functional Responses with Applications in Elite Sports. National University of Ireland Galway, Galway, Ireland. PhD
Supervisors: Newell, J. and **Oliveira, T.P.**

Reviewer

REVIEW SUMMARY



REVIEWER SUMMARY

(3) PeerJ	WOS	(3) International Journal of Sports Physiolo...	WOS
(2) The R Journal	WOS	(2) The Plant Genome	WOS
(2) Plos One	WOS	(1) The Journal of Open Source Software	
(1) Brazilian Journal of Probability and Stat...	WOS	(1) Biology Letters	WOS
(1) Biocontrol Science and Technology	WOS		

Awards

2020 Runner-up Poster on Young-ISA Twitter Poster Conference promoted by the Irish Statistical Association. Poster Title: Global short-term forecasting of Covid-19 cases. Authors: **Oliveira, T.P.**; Moral, R.A., July, 2020

2020 Marie Skodowska-Curie COFUND Fellowship under the project "Quantitative genetics and genomics of plant breeding"

2010 Honorable Mention at the 18^{th} USP International Symposium of Undergraduate Research, University of São Paulo.

Extracurricular courses

2021 Workflows with Nextflow, University of Edinburgh (36h)

2021 Introduction to Bash Shell Scripting, Coursera Project Network (4h)

2021 World Meeting of the International Society for Bayesian Analysis (24h)

2021 Equality & Diversity Essentials (2h)

2021 UKRI-BBSRC Workshop on Computing in the Biosciences (6h)

2021 Challenging Unconscious Bias (1h)

2021 Genome-wide prediction of complex traits in humans, plants and animals (30h)

2020 Programming Fundamentals, Coursera, Duke University, USA. (32h)

2019 Survival Analysis in R. DataCamp, USA. (4h)

2019 Building Web Applications in R with Shiny: Case Studies Course. DataCamp, USA. (4h)

2019 Building Dashboards with shinydashboard. DataCamp, USA. (4h)

2019 Building Web Applications in R with Shiny. DataCamp, USA. (4h)

2019 Introduction to Python. DataCamp, USA. (4h)

2019 Statistical Modeling in R (Part 1). DataCamp, USA. (4h)

2019 Intermediate R. DataCamp, USA. (6h)

2019 Introduction to R. DataCamp, USA. (4h)

2018 Machine Learning Toolbox. DataCamp, USA. (4h)

2016 Longitudinal and Incomplete Data – USP (30h)

2015 Short curse on Regression Models – Coursera, MOOC, USA (36h)

2015 Short curse on Dimensionality Reduction – USP

2015 Additive Generalized Models with P-splines – RBras

2015 Exploring interactive graphical interfaces in R – RBras

2015 Exploring the Flexibility of Linear Mixed Models – RBras

2015 Special Topics in Multivariate Analysis – RBras

2014 Generalized Additive Models with P-splines – USP

2013 Short curse on Statistics: Making Sense of Data – Coursera, MOOC, USA

2013 Short curse on Mathematical Biostatistics Boot Camp – Coursera, MOOC, USA

2013 Introduction to Categorical Data Analysis – USP

2013 Structural Equations Models – USP

2013 Some Important Topics of Asymptotic Theory – USP

Event participation

2022 World Congress on Genetics Applied to Livestock Production (WCGALP)

2021 7th Summer Institute in Statistics for Big Data (SISBID)

2021 Genome-wide prediction of complex traits in humans, plants and animals

2021 Software Licensing Workshop

2020 71^{st} Annual Meeting of European Federation of Animal Science (EAAP)

2020 Why R? 2020 conference organized remotely

2019 The Inaugural Young-ISA Meeting – Maynooth, Co. Kildare, Ireland

2019 — 34^{th} meeting of the International Workshop on Statistical Modelling (IWSM) – Guimarães, Portugal.

2016 — NUIG Statistics MiniSymposium. Longitudinal Concordance correlation function based on variance components: an application in fruit color analysis.

2015 — 30^{th} meeting of the International Workshop on Statistical Modelling (IWSM) – Linz, Vienna.

2015 — 60^{th} meeting of the Brazilian Region International Biometric Society (RBras) e 16° "Simpósio de Estatística Aplicada à Experimentação Agronômica" – Presidente Prudente, SP, Brazil

2015 — How to Write for and Get Published in Scientific Journals – Piracicaba, SP, Brazil

2014 — II Workshop on Longitudinal and Incomplete Data – Piracicaba, SP, Brazil

2014 — I Workshop on Experimental Statistics e IV "Encontro dos Alunos do PPG em Agronomia" – Piracicaba, SP, Brazil

2013 — 58^{th} meeting of the Brazilian Region International Biometric Society e 15° "Simpósio de Estatística Aplicada à Esperimentação Agronômica" – São Paulo, SP, Brazil

2012 — 57^{th} meeting of the Brazilian Region International Biometric Society – Piracicaba, SP, Brazil

2011 — 19^{th} meeting of the USP International Symposium of Undergraduate Research – Piracicaba, SP, Brazil

2010 — 18^{th} meeting of the USP International Symposium of Undergraduate Research – Piracicaba, SP, Brazil

Teaching Experience

Taught Modules

2018 — LCE0602 Experimental Statistics, University of São Paulo, Piracicaba, Brazil, *Agricultural Engineering programme*, August-December.

2018 — LCE0220 Calculus II, University of São Paulo, Piracicaba, Brazil, *Agricultural Engineering programme*, August - December.

2018 — LCE0120 Calculus I, University of São Paulo, Piracicaba, Brazil, *Agricultural Engineering programme*, August - December.

2018 — LCE0120 Calculus I, University of São Paulo, Piracicaba, Brazil, *Agricultural Engineering programme*, February - June.

2018 — LCE0220 Calculus II, University of São Paulo, Piracicaba, Brazil, *Agricultural Engineering programme*, February - June.

2018 — LCE0130 Differential and Integral Calculus, University of São Paulo, Piracicaba, Brazil, *Food Science programme*, February - June.

2017 — LCE0602 Experimental Statistics, University of São Paulo, Piracicaba, Brazil, *Agricultural Engineering programme*, August - December.

2017 — LCE0120 Calculus II, University of São Paulo, Piracicaba, Brazil, *Agricultural Engineering programme*, August - December.

Taught Short Courses

2021 — Visualization and Data Structure on Breeding Programme Modelling with AlphaSimR, University of Edinburgh, Scotland

2018 — I Workshop on Introduction to Experimental Design, University of São Paulo, Piracicaba, Brazil

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Teaching Assistance

2016	LCE0120 - Calculus I, University of São Paulo, Piracicaba, Brazil, taught by Dr. Silvio Sandoval Zocchi for undergraduate students of the Agricultural Engineering programme, 120h
2015	LLCE0220 Calculus II, University of São Paulo, Piracicaba, Brazil, taught by Prof. Idemauro Antonio Rodrigues de Lara for undergraduate students of the Agricultural Engineering programme, August-December, 120h
2015	LLCE0211 Statistics, University of São Paulo, Piracicaba, Brazil, taught by Dr. Silvio Sandoval Zocchi for undergraduate students of the Agricultural Engineering programme, February-June, 120h
2013	LLCE0220 Calculus II, University of São Paulo, Piracicaba, Brazil, taught by Prof. Idemauro Antonio Rodrigues de Lara for undergraduate students of the Agricultural Engineering programme, August-December, 120h
2013	LLCE0166 Calculus and Mathematics Applied to Food Sciences, University of São Paulo, Piracicaba, Brazil, taught by Dr. Silvio Sandoval Zocchi for undergraduate students of the Food Sciences programme, February-June, 120h

Lectured workshops and invited talks

2021	Modelling menstrual cycle length in athletes using state-space models. Statistical weekly meeting, Brazil
2020	Global Short-Term Forecasting of Covid-19 Cases. Webinar Series of the Young-ISA, Ireland
2020	Global Short-Term Forecasting of Covid-19 Cases. Workshop on Applied Statistics: Prediction models for COVID-19, Artificial Intelligence and Postgraduate Research during pandemic time. University of São Paulo, Brazil
2020	Estimating NBA athlete performance using hierarchical models, National University of Ireland Galway, Ireland, 21 April 2020
2019	Modelling athletes menstrual cycle length using state space models. NUI Galway, Ireland
2019	Modelling menstrual cycle length using state space models. The Inaugural Young-ISA Meeting – Maynooth, Ireland
2016	Longitudinal concondance correlation function based on variance components: an application in fruit color – NUI Galway

Professional Websites

Blog	https://prof-thiagooliveira.netlify.app	Link
GitHub	https://github.com/Prof-ThiagoOliveira	Link

Funding - Grants & Contracts

2020-2023	TRAIN@Ed Fellow	Grant

- Marie Skodowska Curie COFUND fellowships
- PI: Gregor Gorjanc
- Quantifying the Drives of Genetic Change in Plant Breeding
- Project Funding: £70, 000

2020-2020	Researcher in Biostatistics	Postdoctoral

- Science Foundation Ireland
- PI: Prof. Carl Scarrott
- Project: Early Detection of Secondary Waves of Covid-19 Infections
- Project Funding: €32,618

2020-2020 Researcher in Biostatistics Postdoctoral

- Science Foundation Ireland
- PI: Prof. John Newell
- Project: Aspire Academy research collaboration project
- Project Funding: €20,000

2019-2019 Researcher in Biostatistics Postdoctoral

- Science Foundation Ireland
- PI: Prof. John Newell
- Project: Development of statistical model with application in athlete performance
- Project Funding: €12,417,097

2018-2019 Researcher in Statistics Postdoctoral

- Coordination of Improvement of Higher Education Personnel
- PI: Prof[a]. Clarice G. B. Demétrio
- Project: Estimation of Longitudinal Concordance Correlation Function: The lcc package
- Grants awarded: approximately £7,000

Media and Impact

Blog posts

Post Moral, R.A.; **Oliveira, T.P.**; Parnell, A. How hard is it to predict COVID-19 cases? 2020. URL: https://www.hamilton.ie/covid19/posts/2020-10-01-how-hard-to-predict-cases/

Post **Oliveira, T.P.** Expressions in C++. 2020. URL: https://prof-thiagooliveira.netlify.app/post/expressions/

Post **Oliveira, T.P.** Signed and Unsigned Binary Numbers. 2020. URL: https://prof-thiagooliveira.netlify.app/post/signed-and-unsigned-binary-numbers/

Post **Oliveira, T.P.** The seven steps of a programer. 2020. URL: https://prof-thiagooliveira.netlify.app/post/the-seven-steps-of-a-programer/

References

Dr. Gregor Gorjanc University of Edinburgh

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