[CV] Ricardo Cruz, PhD

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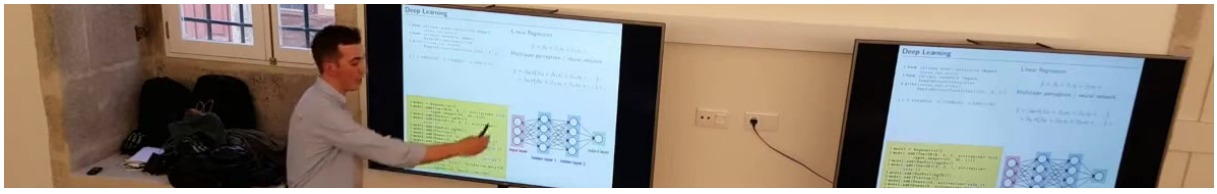
Contents

Ricardo Cruz received a B.S. degree in computer science and an M.S. degree in applied mathematics, both from the University of Porto, Portugal. Since 2015, he has been a researcher at INESC TEC working in machine learning with particular emphasis on computer vision. He earned his Ph.D. in Computer Science in 2021 with a special emphasis on computer vision and deep learning. Currently, he is a post-doctoral researcher on autonomous driving under the THEIA research project, a partnership between the University of Porto and Bosch Car Multimedia.

Skills: Python • C • C++ • Java • R • MATLAB • PyTorch • TensorFlow • OpenCV • SQL • Git



Education

2021 Ph.D. Computer Science (joint degree University of Porto, Minho and Aveiro)
2015 M.Sc. Mathematical Engineering (University of Porto)
2012 B.Sc. Computer Science (University of Porto)

Employment

2021–... **Post-doctoral Researcher** on Autonomous Driving
University of Porto (FEUP) [in partnership with Bosch]
- Collaboration between the University of Porto and Bosch Car Multimedia to improve autonomous driving perception
- Developed frameworks for object detection using camera and LiDAR (2D discretization and raw point-clouds)
- Published new methods for efficient semantic segmentation and ordinal regression
- Supervised six master's theses, four bachelor's projects, and other team members
- Responsible for the HPC infrastructure (using Slurm)

2015–2021 **Research Assistant** on Machine Learning and Computer Vision
INESC TEC
- Research focus: re-thinking fundamentals about image classification and semantic segmentation (8+ publications)
- Some highlights: (1) a method for background invariance using adversarial training, (2) new losses that minimize absolute trade-offs between Type 1 and 2 errors instead of relative trade-offs, (3) using backpropagation also for inference to refine existing outputs, (4) deploying learning-to-rank methods for class imbalance
- Contributed to workshops, Summer School on Computer Vision (VISUM), and other events
- Twice awarded "outstanding recognition" for organizing workshops and helping with the HPC infrastructure

2014 **Research Grant** on Mathematical Modelling Research
Mathematics Center of the University of Porto (CMUP)
- Epidemiological models for HIV. A little of everything: from differential equations to stochastic simulations to cellular automata.

Teaching

2021–2022 **Invited Auxiliary Professor,** University of Porto (FEUP)
2018–2021 **Invited Teacher Assistant,** University of Porto (FEUP)

Courses

The teaching consisted of the pratical lessons (2h-4h per week) and helping with the materials. These courses took place during my PhD (as an Invited Teacher Assistant) and then as a Post-Doc (as an Invited Auxiliary Professor).

- L.EIC003: Programming Fundamentals (Python) [L.EIC] (2018/2019, 2019/2020, 2020/2021, 2021/2022)
- L.EIC009: Programming (C/C++) [L.EIC] (2019/2020, 2020/2021)
- L.EEC009: Data Structures and Algorithms (C/C++) [L.EEC] (2021/2022)

Awards

2022 **Bosch for Mobility:** My students won Best New Participating Team in an autonomous driving competition

2021 **INESC TEC Outstanding Recognition Award:** Monthly award for INESC TEC collaborators, for maintenance of the HPC infrastructure
2021 **Pedagogic award (voted by students):** University of Porto (FEUP)
2021 **Best paper and presentation:** RECPAD conference
2018 INESC TEC Outstanding Recognition Award: Monthly award for INESC TEC collaborators, for organizing workshops
2017 **Kaggle Bronze Medal (competition) and Silver (engagement)**

Selected Projects

See my github for more projects: github.com/rpmcruz.

- **Uber Pixor implementation.** Implementation of a popular bird's eye view LiDAR object detection model.
- **objdetect package.** Light-weight and versatile one-stage object detection framework.
- **Human Feedback during Neural Network Training.** When a model makes a wrong prediction, a typical solution is to acquire more data related to the error – this is an expensive process known as active learning. Our proposal combines active learning with interpretability so the user can correct such mistakes while the model trains. This work resulted in a thesis that I supervised.
- **Neural Networks Robust to Background Changes.** While training an electrical insulator detector, we noticed a large drop in accuracy when going from the controlled studio (training set) to outdoors (testing set). The proposed method uses a background generator to generate adversarial backgrounds and a mask generator to introduce this background to the training image. A paper was published from this work.
- **Annotation Aid Tool using GrabCut.** Annotations were necessary for a project whose goal was to learn a sequential segmentation model for the movement of mice. For that purpose, I developed a small tool to aid the annotation effort. The tool processes the video frames sequentially in two steps: (1) the annotator first selects the region where the mouse is, and (2) the annotator selects some positive pixels (left-click) and negative pixels (right-click) until he/she is satisfied with the segmentation produced by the GrabCut algorithm.
- **Classification of Cervical Cancer Risk.** Cervical cancer is the fourth leading cause of cancer-related deaths in women. The goal of the TAMI project was to automate cervical cancer screening via Pap smears. A non-parametric ordinal loss for neuronal networks was proposed to promote ordinal output probabilities (accuracy of 75.6
- **Apoo (virtual machine) GTK+ interface.** I helped with the development of the GTK+ interface for Apoo (together with Profs Rogério Reis and Nelma Moreira), a virtual machine that is currently being used to teach Assembly. Apoo is written in Python and GTK+.
- **EatFeed.** RSS/Atom reader written in C++ and GTK+.
- **Google Summer of Code.** I was awarded twice a Google grant to work on open-source projects. LibreOffice dynamic layouts (2007) and YaST port from GTK+ to Qt (2006).
- **J2ME and Android games.** Games written in Java Mobile Edition; more recently, I ported a couple of them to Android.
- **SuperTux, co-author.** While in high-school, I was part of the initial team developing

this game. It is written in C++, SDL, and OpenGL.

Participation in Scientific Projects

- Post-doc researcher (2021–2023) on THEIA – Automated Perception Driving (POCI-01-0247-FEDER-047264)
- Research member (2018–2021) of CLARE – Computer-aided cervical cancer screening (POCI-01-0145-FEDER-028857)
- Masters research grant (2015–2016) on NanoSTIMA – Macro-to-Nano Human Sensing: Towards Integrated Multimodal Health Monitoring and Analytics (NORTE-01-0145-FEDER-000016)
- Bachelors research grant on statistical epidemiological modelling (2014) (PEst-C/MAT/UI0144/2013)

Participation in Scientific Events

- **iMIMIC/MIL3ID/LABELS 2020 workshop proceedings** (MICCAI 2020): co-editor
- **iMIMIC 2020 workshop** (MICCAI 2020): committee sponsor chair
- **3rd International Conference on Dynamics, Games and Science (2014):** president of the organizing committee

Participation in Workshops or Competitions

- 2022: **Bosch for Mobility:** My students won Best New Participating Team in an autonomous driving competition promoted by Bosch Romania.
- 2019: **DSPT Day:** lightning talk (a two-day machine learning event for a public audience)
- 2018: **Junior University:** organized with my supervisor (Prof. Jaime Cardoso) an activity for the Junior University entitled "Escondidos nos Dados". The Junior University is an opportunity that the University of Porto gives children to get to know and do activities at the university. This activity took place for a month, with classes with different children every day, from the 8th and 9th grades. The website archives is not working, but this link describes an award I received from INESC TEC for organizing these activities, among others.
- 2018: **VISUM:** helped prepare a computational framework in which students submitted processes and generated Kaggle-style leaderboards (using Google Cloud) for the competitions that take place during the VISUM computer vision summer school, a framework that continues to be used today.
- 2017: organized some workshops, especially at INESC TEC, namely **Learning from Data**, which was part of the CTM Open Day. (The CTM is the INESC TEC unit that I was part of.)
- 2017: Free public workshop, in collaboration with João Machado, in the **Python Meetup** entitled *NumPy and Scikit-Learn*. The Python Meetup was a monthly meeting about Python in Porto, which has since been discontinued.

Impact and Citations

- Google Scholar (may/2023): 171 citations, 7 h-index
- Web of Science (may/2023): 73 citations, 4 h-index
- Scopus (may/2023): 111 citations, 5 h-index
- Best oral paper: 2021 RECPAD conference

Conference Publications

My favorite publications are in highlight.

1. P. S. Silva, **R. Cruz**, ASM Shihavuddin, T. Gonçalves (2023) [**ACCEPTED**]. Interpretability-Guided Human Feedback During Neural Network Training. *Springer Iberian conference on pattern recognition and image analysis (Ibpria)*
2. D. Silva, **R. Cruz**, T. Gonçalves, D. Carneiro (2022) [**ACCEPTED**]. Two-stage Semantic Segmentation in Neural Networks. *Proceedings of the Fifteenth International Conference on Machine Vision (ICMV)*
3. **R. Cruz**, R. Prates, E. Filho, J. Costa, J. Cardoso (2021). Background Invariance by Adversarial Learning. *IEEE 25th International Conference on Pattern Recognition (ICPR)*
4. **R. Cruz**, J. Costa, J. Cardoso (2019). Automatic Augmentation by Hill Climbing. *Springer 28th International Conference on Artificial Neural Networks (ICANN)*
5. **R. Cruz**, J. Costa, J. Cardoso (2019). Averse Deep Semantic Segmentation. *IEEE 41st Engineering in Medicine and Biology Conference (EMBC)*
6. **R. Cruz**, M. Silveira, J. Cardoso (2018). A Class Imbalance Ordinal Method for Alzheimer's Disease Classification. *IEEE International Workshop on Pattern Recognition in Neuroimaging (PRNI)*
7. K. Fernandes, **R. Cruz**, J. Cardoso (2018). Deep image segmentation by quality inference. *IEEE International Joint Conference on Neural Networks (IJCNN)*
8. **R. Cruz**, K. Fernandes, J. Costa, J. Cardoso (2017). Constraining type II error: building intentionally biased classifiers. *Springer International Work-conference on Artificial Neural Networks (IWANN)*
9. M. Pérez-Ortiz, K. Fernandes, **R. Cruz**, J. Cardoso (2017). Fine-to-coarse ranking in ordinal and imbalanced domains: an application to liver transplantation. *Springer International Work-conference on Artificial Neural Networks (IWANN)*
10. **R. Cruz**, K. Fernandes, J. Costa, M. Pérez-Ortiz, J. Cardoso (2017). Combining ranking with traditional methods for ordinal class imbalance. *Springer International Work-conference on Artificial Neural Networks (IWANN)*
11. "**R. Cruz**, K. Fernandes, J. Costa, M. Pérez-Ortiz, J. Cardoso (2017). Ordinal class imbalance with ranking. *Springer Iberian conference on pattern recognition and image analysis (Ibpria)*
12. **R. Cruz**, K. Fernandes, J. Costa, J. Cardoso (2016). Tackling class imbalance with ranking. *IEEE International Joint Conference on Neural Networks (IJCNN)*

Journal Publications

1. **R. Cruz**, D. Silva, T. Gonçalves, D. Carneiro, J. Cardoso (2023). Two-Stage Framework for Faster Semantic Segmentation. *MDPI Sensors*
2. T. Albuquerque, L. Rosado, **R. Cruz**, M. Vasconcelos, T. Oliveira, J. Cardoso (2023). Rethinking Low-Cost Microscopy Workflow: Image Enhancement using Deep Based Extended Depth of Field Methods. *Elsevier Intelligent Systems with Applications*
3. T. Albuquerque, **R. Cruz**, J. Cardoso (2022). Quasi-Unimodal Distributions for Ordinal Classification. *MDPI Mathematics*
4. T. Albuquerque, **R. Cruz**, J. Cardoso (2021). Ordinal Losses for Classification of Cervical Cancer Risk. *PeerJ Computer Science*
5. R. Prates, **R. Cruz**, A. Marotta, R. Ramos, E. Filho, J. Cardoso (2019). Insulator visual non-conformity detection in overhead power distribution lines using deep learning. *Springer Journal Computers & Electrical Engineering*
6. **R. Cruz**, K. Fernandes, J. Costa, M. Pérez Ortiz, J. Cardoso (2018). Binary ranking for ordinal class imbalance. *Springer Journal Pattern Analysis and Applications*

Collaborations as Editor or Evaluator

2021 **A3ES:** student member (as a PhD student) of three evaluation committees: a master's course and two doctorates.

2020 **iMIMIC/MIL3ID/LABELS 2020 workshop proceedings (MICCAI 2020):**

helped organize the iMIMIC 2020 workshop (part of MICCAI 2020) and was later co-editor of the publication of the joint proceedings of three MICCAI 2020 workshops.

Jury Participation

2022 Mafalda Oliveira: *Neuroblastoma Cancer Radiogenomics* (FEUP, External Examiner)

2022 João Pedro Fonseca: *AI-Based Models to Predict The Traumatic Brain Injury Outcome* (FEUP, External Examiner)

2022 Ana Maria Sousa: *Learning to write medical reports from EEG data* (FEUP, Chairman)

2022 Bruno Nascimento: *Detection and classification of small impacts on vehicles based on deep learning algorithms* (U. Minho, External Examiner)

2021 Artur Ferreira: *3D Lung Computed Tomography Synthesis using Generative Adversarial Networks* (FCUP, External Examiner)

2021 Vítor Figueiredo: *Feasibility of using autoencoders for learning car interior background models* (U. Minho, External Examiner)

M.Sc. Supervisions

on-going Rafael Cristino: *Introducing Domain Knowledge to Autonomous Driving* (FEUP)

on-going Alankrita Asthana: *Iterative Inference for Point-Clouds* (TUM, Munich)

on-going José Guerra (with L. Teixeira): *Academic Internship in Out of Distribution Detection – Autonomous Driving* (Internship at Bosch Car Multimedia) (FEUP)

2022 Pedro Silva (with T. Gonçalves): *Human Feedback during Neural Networks Training* (FEUP)

2022 João Silva: *Environment Detection for Railway Applications based on Automotive Technology* (Internship at Continental) (FEUP)

2022 Ana Bezerra (with J. Costa): *Phishing Detection with a Machine Learning Net* (Internship at E-goi) (FCUP)

B.Sc. Projects Supervisions

2022 Diana Silva (with T. Gonçalves): *Semantic Segmentation in Neural Networks using Iterative Visual Attention*

2022 Filipe Campos, Francisco Cerqueira, Vasco Alves: *Mobile App using Object Detection for Car Driving*

2022 Bruno Gomes, Rafael Camelo: Internship at ANO