Milton O. Candela-Leal

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Education

Tecnológico de Monterrey - Monterrey, Mexico 2020 - Dec 2024
BS in Biomedical Engineering (95/100 = 3.88/4.00 GPA)
- Highest honors (*Summa Cum Laude*) and highest award for co-curricular success (*Excellence Diploma*); *Borrego de Oro* in professional development.

International Baccalaureate - Monterrey, Mexico 2018 - 2020
Math HL, Psychology SL, Physics SL, ...
Thesis: [Film & Psychology] *Harry Potter and the Prisoner of Azkaban* (2004), a Cultural and Ideological Instructor of the Millennial Viewer

Research Experience

Tecnológico de Monterrey - Monterrey, Mexico Mar 2021 - Jul 2023, Fall 2024
NSF IUCRC BRAIN Center
Advisor: Prof. Mauricio A. Ramírez-Moreno, PhD
Projects: Biometrics (EEG, ECG, CV) and Machine Learning to predict:
Mental fatigue (2021); engineering interest (2021); emotion (2023).
- Force prediction through pose estimation keypoints and RNN (2022).
- Cognitive load in chess (2023); closed-loop BCI for attention (2024).

Harvard Medical School - Boston, MA, USA Aug 2023 - Jul 2024
Boston Children's Hospital
Advisor: Prof. Kiho Im, PhD
Projects: Fetal MRI subplate segmentation (attention U-Net); non-linear qMRI for congenital heart disease classification; MICCAI FeTA Challenge 2024.

University of Houston - Houston, TX, USA Spring 2022
NSF IUCRC BRAIN Center
Advisor: Prof. Jose L. Contreras-Vidal, PhD
Project: EEG functional connectivity and bisprectrum analysis between actors.

Journal Articles

(† indicates equal contribution)

Mandujano-Granillo, J.A., **Candela-Leal, M.O.**, Ortiz-Vazquez, J.J., ... Lozoya-Santos, J.J. (2024). Human-Vehicle Interfaces: A Review for Autonomous Electric Vehicles. IEEE Access, 12, 121635–121658. doi:10.1109/ACCESS.2024.3450439

Blanco-Ríos, M.A.†, **Candela-Leal, M.O.**†, Orozco-Romo, C., ... Ramírez-Moreno, M.A. (2024). Real-time EEG-based Emotion Recognition for Neurohumanities: Perspectives from Principal Component Analysis and Tree-based Algorithms. Frontiers in Human Neuroscience, 18, 1319574. doi:10.3389/fnhum.2024.1319574. PubMed PMID:38545515

Candela-Leal, M.O., Gutiérrez-Flores, E.A., Presbítero-Espinosa, G., ... Ramírez-Moreno, M.A. (2022). Multi-Output Sequential Deep Learning Model for Athlete Force Prediction on a Treadmill Using 3D Markers. Applied Sciences, 12(11), 5424. doi:10.3390/app12115424

Ramírez-Moreno, M.A., Carrillo-Tijerina, P., **Candela-Leal, M.O.**, ... Lozoya-Santos, J.J. (2021). Evaluation of a Fast Test Based on Biometric Signals to Assess Mental Fatigue at the Workplace—A Pilot Study. International Journal of Environmental Research and Public Health, 18(22), 11891. doi:10.3390/ijerph182211891. PubMed PMID:34831645

Book Chapters

Lozoya-Santos, J.J., Ramírez-Moreno, M.A., **Candela-Leal, M.O.**, ... Ramirez-Mendoza, R.A. (2022). Current and Future Biometrics: Technology and Applications. In R.A. Ramirez-Mendoza, J.J. Lozoya-Santos, R. Zavala-Yoé, ... H.G. Gonzalez-Hernandez (Eds.), Biometry: Technology, Trends and Applications (1st ed., pp. 1–30). Boca Raton, FL: CRC Press. doi:10.1201/9781003145240-1. ISBN: 9781003145240.

Conference Proceedings

Candela-Leal, M.O., Aguilar-Herrera, A.J., Ramírez-Moreno, M.A., ... Lozoya-Santos, J.J. (2024). Conscious Technologies Projects as a Hub for Real Life Challenges in Engineering Education. In 15th EDUCON (pp. 665-675). Kos, Greece: IEEE. doi:10.1109/EDUCON60312.2024.10578738

Candela-Leal, M.O., Martínez-Díaz, D., Orozco-Romo, C., ... Ramírez-Moreno, M.A. (2023). Biomechanics Digital Twin: Markerless Joint Acceleration Prediction Using Machine Learning and Computer Vision. In Future of Educational Innovation-Workshop Series: Data in Action (pp. 142-150). Monterrey, Mexico: IEEE. doi:10.1109/IEEECONF56852.2023.10104757

Candela-Leal, M.O., García-Briones, J.M., Olivas-Martínez, G., ... Lozoya-Santos, J.J. (2021). Real-time Biofeedback System for Interactive Learning using Wearables and IoT. In 6th North American IEOM (pp. 2959-2970). Monterrey, Mexico: IEOM **(best undergraduate paper award)**. doi:10.46254/NA06.20210487

Olivas-Martínez, G., **Candela-Leal, M.O.**, Ocampo-Alvarado, J.C., ... Ramírez-Moreno, M.A. (2021). Detecting Change in Engineering Interest in Children through Machine Learning using Biometric Signals. In Machine Learning-Driven Digital Technologies for Educational Innovation Workshop (pp. 33-40). Monterrey, Mexico: IEEE. doi:10.1109/IEEECONF53024.2021.9733772

Aguilar-Herrera, A.J., Delgado-Jimenez, E.A., **Candela-Leal, M.O.**, ... Ramirez-Mendoza, R.A. (2021). Advanced Learner Assistance System's (ALAS) recent results. In Machine Learning-Driven Digital Technologies for Educational Innovation Workshop (pp. 26-33). Monterrey, Mexico: IEEE. doi:10.1109/IEEECONF53024.2021.9733770

Invited Talks

Decoding Cognitive Performance, 2024
Cognitive Neuroscience minor, Tecnológico de Monterrey - School of Humanities and Education

Computer Vision and Facial Recognition, 2023
Computing Seminar course, UANL - School of Physics and Mathematics

Working Papers

Ramírez-Arceo, G.A., **Candela-Leal, M.O.**, Tudon-Martinez, J.C., ... Ramírez-Moreno, M.A., (*accepted*). Innovative Spaces With Advanced Technologies Such as Research Activity Simulators for Engineering Education. In 16th EDUCON. London, United Kingdom: IEEE

Ramírez-Moreno, M.A., Romero-Días, D.C., **Candela-Leal, M.O.**, ... Lozoya-Santos, J.J. (*under review*). Workplace Measures of Mental Fatigue.

Candela-Leal, M.O., Alanis-Espinosa, M., Murrieta-González, J., ... Ramírez-Moreno, M.A. *(under review)*. Neurocognitive Insights into STEM Learning: An Integrated Analysis of Bandpower and Functional Connectivity among Youth

Candela-Leal, M.O., Lozoya-Santos, J.J., Ramírez-Moreno, M.A. (*in prep*). Central Theta for Task Completion Time Estimation during Chess-Based Problem-Solving using Single-Channel EEG

Candela-Leal, M.O., Martínez-Hernández, A., Moreno-Salazar, I.E., ... Ramírez-Moreno, M.A. (*in prep*). EEG-Based Spherical Model for Emotion and Fear Prediction with Biometric Validation

Candela-Leal, M.O., Ramírez-Arceo, G.A., Ramírez-Moreno, M.A., ... Lozoya-Santos, J.J. (*in prep*). Neurohumanities Lab as an Educational Immersive Virtual Reality Space

Presentations

Oral Presentations

Digital Twins in Education: Enhancing Student Well-being and Academic Performance with Biometric Insights and Machine Learning. *U21 Health Sciences Group 2024 Annual Meeting*, Amsterdam University Medical Centers (Amsterdam, Netherlands) **(student speaker award)** 2024

High-resolution Fetal Subplate Automatic Segmentation. *FNNDSC Research Symposium*, Boston Children's Hospital (Boston, MA) 2024

CHD Fetal Brain Analysis using Combined Quantitative MRI Features and Custom-build Loss Functions. *FNNDSC Research Symposium*, Boston Children's Hospital (Boston, MA) 2024

Biomechanics for the Digital Twin of Performance: Study Cases. *Conscious Technologies for Smart Communities Workshop* (Virtual) 2021

Harry Potter and the Prisoner of Azkaban (2004), a Cultural and Ideological Instructor of the Millennial Viewer. *51th Research and Development Congress* (Virtual) 2021

Poster Presentations

FALCONS: Fetal Automatic Landmark Computation and Optimization for Neuroimaging Segmentation. *27th International Conference on MICCAI* (Marrakesh, Morocco) 2024

Real-time Dual-feature Mental Fatigue State SVM Classification using EEG Delta Bandpower. *19th IEEE-EMBS International Conference on BSN*, MIT Media Lab (Boston, MA) 2023

Talent Detection Tool for Early Engineering Education. *NSF IUCRC BRAIN 2023 Annual Meeting*, Arizona State University (Phoenix, AZ) 2023

Human Machine Interface for Fleet Electric Vehicles. *NSF IUCRC BRAIN 2023 Annual Meeting*, Arizona State University (Phoenix, AZ) 2023

Biometric Cabin for Neurohumanities Lab. *NSF IUCRC BRAIN 2023 Annual Meeting*, Arizona State University (Phoenix, AZ) 2023

Digital Twin modeling for Human Biomechanics and Office Spaces. *NSF IUCRC BRAIN 2022 Annual Meeting*, University of Houston (Houston, TX) 2022

Brain on Acting: Neural Dynamics of Actor-Actor Dyads During an Acted Scene. *NSF IUCRC BRAIN 2022 Annual Meeting*, University of Houston (Houston, TX) 2022

Identifying Engineering Interest in Children through Machine Learning using Biometric Signals. *43rd Annual Conference of the IEEE-EMBS* (Virtual) 2021

ALAS: Advanced Learner Assistance System for Engineering Education using Wearable Sensors. *43rd Annual Conference of the IEEE-EMBS* (Virtual) 2021

Digital Twin of Biomechanics: Joint Force Prediction using Video and AI. At the *NSF IUCRC BRAIN 2021 Annual Meeting* (Virtual) 2021

Detection of Engineering Interest in Children Through an Intelligent System Using Biometric Signals. At the *NSF BRAIN 2021 Annual Meeting* (Virtual) 2021

NON-INTERNATIONAL PRESENTATIONS

Poster Presentations

Closed-Loop BCI with Haptic Feedback and SINDy Algorithm for Attention Support in ADHD Students. At the *24th Expo Ingenierías*, Tecnológico de Monterrey (Monterrey, Mexico) 2024

Biometric Cabin with Portable Real-Time Monitoring Technology for Smart Solutions. At the *21st Expo Ingenierías*, Tecnológico de Monterrey (Monterrey, Mexico) 2023

Neurohumanities Lab. At the *21st Expo Ingenierías*, Tecnológico de Monterrey (Monterrey, Mexico) 2023

Comparison of Brain Synchronization between Pairs during Collaborative and Competitive Tasks. At the *21st Expo Ingenierías*, Tecnológico de Monterrey (Monterrey, Mexico) 2023

Real-Time Knee Flexion Angle for Anterior Cruciate Ligament Injury using Computer Vision. At the *BMEX: Engineering and Health Sciences Symposium*, Tecnológico de Monterrey (Monterrey, Mexico) 2023

Advanced Learner Assistance System (ALAS). At the *20th Expo Ingenierías*, Tecnológico de Monterrey (Monterrey, Mexico) 2022

Real-Time Knee Flexion Angle for Anterior Cruciate Ligament Injury using Computer Vision. At the *20th Expo Ingenierías*, Tecnológico de Monterrey (Monterrey, Mexico) 2022

Digital Twin Office for Workspace Throughput Monitoring. At the *19th Expo Ingenierías*, Tecnológico de Monterrey (Monterrey, Mexico) 2022

Biomechanics For the Digital Twin of Performance. At the *19th Expo Ingenierías*, Tecnológico de Monterrey (Monterrey, Mexico) 2022

Advanced Learner Assistance System. At the *19th Expo Ingenierías*, Tecnológico de Monterrey (Monterrey, Mexico) 2022

Detection of Engineering Interest in Children Through an Intelligent System Using Biometric Signals. At the *18th Expo Ingenierías* (Virtual) 2021

Real-time Biofeedback System for Interactive Learning using Wearables and IoT. At the *18th Expo Ingenierías* (Virtual) 2021

Biomechanics for the Digital Twin of Performance. At the *18th Expo Ingenierías* (Virtual) 2021

Advanced Learner Assistance System (ALAS) for Engineering Education using Wearable Sensors. At the *17th Expo Ingenierías* (Virtual) 2021

Honors and Awards

Summa Cum Laude, Tecnológico de Monterrey 2024
- Highest academic distinction.

Excellence Diploma, Tecnológico de Monterrey 2024
- Highest award for co-curricular and academic excellence.

Borrego de Oro, Tecnológico de Monterrey 2024
- #1 in professional development, among ∼1,500 December 2024 graduates.

International Diploma, Tecnológico de Monterrey 2024
- Global leadership and multilingual excellence through academic achievements.

Student Speaker Award, U21 Health Sciences Group 2024
- One of the two teams that won funding ($1600 USD) to present at U21 HSG '24, selected from MSc/BSc research projects across 21 universities on all continents.

Outstanding Student Award, Tecnológico de Monterrey 2023, 2024
- 1% of all engineering students with the most outstanding trajectories [80/8000].

1st Place - Undergraduate Student Paper Competition, 6th North American IEOM 2021

1st Place - R&D Improvement Proposals ($250 USD), 18th Conexión Tec 2021

Academic Talent Scholarship, Tecnológico de Monterrey 2020

Teaching

German A2 Teacher, Mentoor MX 2022-2024

Middle School Math and Spanish Teacher, Aprendamos Juntos 2021-2022

Independent High School Physics Teacher Fall 2019

FIRST® LEGO® League Mentor, Little Minds Spring 2019

Press

(Spanish) Conecta: Of Gold! Monterrey Campus Graduates Acknowledged for Holistic Formation 2024

(Spanish) Conecta: They receive recognition for their AI learning project and take it to Amsterdam! 2024

Skills Summary

Languages Python (3 years), R (2 years), MATLAB (1 year), Shell (3 months), SQL (3 months)
English (C1), German (B1), Spanish

Frameworks Numpy, Scipy, Pandas, Matplotlib, Scikit-learn, OpenCV, TensorFlow, Keras, BrainFlow
FSL, FreeSurfer, MRtrix3, ANTs, NiBabel, PyDicom, IRTK, NUC, TochIO, MNE, OSC
Lattice, Dplyr, Tidyr, Caret, GA, Ggplot, Shiny

Tools Git, Anaconda, CUDA, CMake, Tableau, Microsoft Excel, G*Power, Overleaf, LaTeX

Platforms Linux, ROS, Windows, Arduino, Raspberry

Projects

Closed-loop BCI for Attention - *Tecnológico de Monterrey* 2024
- Real-time analog haptic neurofeedback when the model predicts low attention
- Collected 4-channel EEG CPT-II data, further validated using a 12-min video
- Trained a 3-feature MLR model that predicted attention continuously (0.72 R^2)

FeTA Challenge @ MICCAI - *Harvard Medical School* 2024
- 7-label dataset (CSF, GM, WM, Ventricles, Cerebellum, Deep GM, Brainstem)
- Pre-processed multi-site data; evaluated model zoo performance on in-house data
- Trained a MRI U-Net model with spatial and resolution augmentation (0.76 Dice)

High-res Fetal Subplate Segmentation - *Harvard Medical School* 2024
- Upsampled, aligned, and corrected subplate segmentation in a higher resolution
- Implemented Bivariate Gaussian Smoothing (BGS) for step-like borders
- Trained a MRI U-Net leveraged by transfer-learning for segmentation (0.98 Dice)

Non-linear qMRI for CHD Classification - *Harvard Medical School* 2024
- Designed Recursive RF importance (RRFi) for feature selection (20,453)
- Discovered and proposed new biomakers in fetal CHD brain identification
- Created a 5-feature kNN model with 0.88 F1-score (0.10 better than baseline)

Real-time Emotion Recognition - *Tecnológico de Monterrey* 2022-2023
(Neurohumanities Lab)
- Reduced 32-channel DEAP dataset dimensionality into optimal config
- Designed a channel selection pipeline using lobe-based PCA and RF
- Created an 8-channel EEG VAD 15 emotion recognition model (94% accuracy)

Cognitive Load Dynamics in Chess - *Tecnológico de Monterrey* 2023
- Designed, led, and processed 37 chess players under ambient/white noise
- Calculated Task Completion Time (TCT) based on EEG biomarker theta C4
- Validated TCT with Cognitive Load Theory (CLT), stratifying by chess level

Digital Twin of the Workspace - *Tecnológico de Monterrey* 2022
- Designed a throughput monitoring system via Human Action Recognition (HAR)
- Integrated Velodyne LiDAR pointcloud with CV tracking using CCTV footage
- Fitted a RNN HAR model (Walking, Running, Jumping) using CV human keypoints

Brain on Acting - *University of Houston* 2022
- Recorded a play using 32-electrode EEG on two actors and the director
- Calculated bispectrum signal for the combination of pairs using MATLAB
- Assessed the difference in moments of gaze via Wilcoxon Rank-Sum Test

Biomechanical Force Prediction - *Tecnológico de Monterrey* 2021-2022
(Biomechanics for the Digital Twin)
- Used OpenPose API and DLT to markerless track an individual's joints
- Predicted the force exerted by using raw human pose keypoints
- Designed and trained an RNN using Tensorflow and Keras in Python (0.92 R^2)

Mental Fatigue Prediction - *Tecnológico de Monterrey* 2021
(Advanced Learner Assistance System [ALAS])
- Feature engineered 4-electrode EEG & ECG wearables features using R
- Developed and tuned a ML algorithm that predicted mental fatigue via Python
- Optimized to use the least amount of non-linear combined features (2) (93% accuracy)

Interest in STEM Prediction - *Tecnológico de Monterrey* 2021
(Talent and Passion Detection Through Biometrics)
- Trained ML regression models with biometrics (EEG, ECG, and CV emotions)
- Predicted change in vocational interest after a STEM lecture using Python
- Validated the algorithm with STEM-CIS ground-truth psychometric test (80% accuracy)

MEMBERSHIPS

SACNAS Mar 2024 - Mar 2025

AUDITED COURSES

Harvard - Department of Psychology
PSY 3340 Research Seminar in Cognition, Brain, and Behavior - *T. Ullman* Spring 2024
PSY 1322 The Cognitive Science of Making Up Your Mind - *T. Ullman* Spring 2024

MIT - Department of Brain and Cognitive Sciences (BCS)
9.014 Quantitative Methods and Computational Models in Neuroscience - *M. Jazayeri* Fall 2023
9.66 Computational Cognitive Science - *J. Tenenbaum* Fall 2023

PROFESSIONAL DEVELOPMENT

MIT - Department of Brain and Cognitive Sciences (BCS)
(Workshop) Exploring New Horizons: Strategies for Success in new Scientific Field 2024
(Symposium) McGovern Institute: Transformational Strategies in Mental Health 2024
(Symposium) McGovern-MEGIN: MEGnificent brain discoveries 2024

Tecnológico de Monterrey
(Course) Data Science - *Crystal System* (150 h) 2022
(Workshop) Biosignal processing in Python - *Neuroengineering and Neuroacoustics* 2021
(Hackathon) HackMTY 2021
(Hackathon) B-Hack - *43th National Biomedical Engineering Congress* 2020
(Course) Systemic Change - *Ashoka* 2020

COURSERA SPECIALIZATIONS

Johns Hopkins University
Data Science (288 h) 2021
Neuroscience and Neuroimaging (42 h) 2020
Health Informatics (56 h) 2020
Patient Safety (54 h) 2020
Healthcare IT Support (20 h) 2021

University of Michigan

Applied Data Science with Python (145 h) 2021

DeepLearning.AI
AI for Medicine (72 h) 2021

Imperial College London
Infectious Disease Modelling (65 h) 2021

Alberta Machine Intelligence Institute
Machine Learning: Algorithms in the Real World (41 h) 2020

IBM - *edX*
Fundamentals of AI (80 h) 2020

Rice University
Fundamentals of Immunology (69 h) 2020

University of Colorado System
Applied Cryptography (34 h) 2020

University System of Georgia
Six Sigma Green Belt (49 h) 2020

Duke University
Excel to MySQL: Analytic Techniques for Business (109 h) 2021