

# Elliott Forney, PhD

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## Summary

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I am a scientist and engineer who specializes in building cutting-edge artificial intelligence and machine learning systems. I have extensive experience with computer vision, remote sensing, natural language processing and biomedical signal analysis. I also have broad interests in computer science, including software engineering, data science, high-performance computing and optimization. I thrive on continual learning and scientific research and I enjoy publishing papers, mentoring junior team members and contributing to open-source projects.

## Education

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Doctor of Philosophy, Computer Science ..... Dec. 2019  
Colorado State University  
Dissertation: *Convolutional Neural Networks for EEG Signal Classification in Asynchronous Brain-Computer Interfaces*

Master of Science, Computer Science ..... Dec. 2011  
Colorado State University  
Thesis: *Electroencephalography Classification by Forecasting with Recurrent Neural Networks*

Bachelor of Science, Computer Science ..... May 2006  
Double Major, General Mathematics  
Colorado State University

## Experience

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Maxar Technologies  
Principal R&D Scientist, Analytics & Solutions ..... Mar. 2024 – Present  
Senior R&D Scientist, Maxar Labs ..... Mar. 2021 – Mar. 2024

- Worked with teams of scientists, engineers and domain experts to develop AI/ML-based systems for analyzing large volumes of high-resolution and multi-spectral satellite imagery.
- Designed, implemented and trained semantic segmentation models and other software components for automated mapping, land-use / land-cover analysis and change detection systems.
- Developed machine learning based and algorithmic approaches for intelligent seamline generation in a large-scale automated image mosaicing system.
- Experimented with self-supervised and generative methods, including context encoders, Generative Adversarial Networks (GANs) and Denoising Diffusion Probabilistic Models (DDPMs).
- Developed a configurable and extensible model training framework that is designed for geospatial data and promotes code reuse, rapid iteration and systematic tracking of models and metrics.
- Mentored multiple summer interns who worked on projects related to deep learning.

IBM

Machine Learning Architect, Watson NLU ..... Sept. 2020 – Mar. 2021  
Machine Learning Engineer, Watson NLU ..... Aug. 2017 – Sept. 2020

- Worked on a team of highly talented machine learning engineers to design, implement and grow an inner-source library for Natural Language Processing (NLP) that powers multiple IBM products.
- Developed components for a high-performance Named Entity Recognition (NER) system that includes multiple taggers, text spans, confidence scores, disambiguation and support for over 12 languages.
- Experimented with novel deep learning approaches for performing concept extraction, entity disambiguation and sentiment analysis using recurrent and convolutional networks.
- Designed, implemented and maintained microservices, using Python, C++, JavaScript, Elixir, Docker and Kubernetes, that provide the backend for the Watson Natural Language Understanding (NLU) cloud APIs.
- Organized and hosted a biweekly learning guild that explored topics in machine learning, natural language processing and software engineering.

Colorado State University, Department of Computer Science

Graduate Research Assistant, Brain-Computer Interfaces Lab. .... May 2011 – Aug. 2017

- Performed research related to deep neural networks for EEG signal analysis and classification in noninvasive Brain-Computer Interfaces (BCIs) as part of an NSF-funded research grant.
- Implemented and experimented with numerous machine learning algorithms for signal analysis, including convolutional and recurrent networks, autoregressive models, discriminant analysis, self-organizing maps, signal fraction analysis, evolutionary optimization and correlative optimization.
- Contributed to the process of writing research grants and applying for institutional review board approval for experiments with human subjects.
- Assisted with EEG recording sessions for multiple studies, including recording data from people with disabilities in their homes.
- Mentored and supervised undergraduate and junior graduate researchers.
- Published and presented results in prominent journals and conferences.

Colorado State University, Department of Computer Science

Graduate Systems Administrator ..... May 2008 – Jan. 2012

- Managed several hundred workstations and servers running various flavors of Linux and UNIX in a scientific computing and research oriented environment.
- Developed custom applications for monitoring, alerting, management of shared resources, distribution of system configurations and software installations and updates.
- Troubleshoot various software and hardware problems for students, faculty and professors in the computer science department.
- Assisted with the design and expansion of various technology resources, including storage systems, GPUs, high-performance networks and multiple high-performance computing clusters.

West Corporation

Programmer Analyst, UNIX App. Admin. Team ..... June 2006 – Aug. 2007

- Developed custom scripts and software for supporting automated deployments, monitoring and alerting.
- Provided production support for numerous public and proprietary software applications related to automated voice response (AVR), Text-To-Speech (TTS), Automatic Speech Recognition (ASR), Telecommunications and various other software systems.
- Worked in a small team to manage software applications running on thousands of Linux and UNIX servers in a distributed, high-volume and high-availability environment.
- Implemented privacy and security safeguards, performed security audits, performed digital forensics and mitigated cybersecurity threats.

## Full-Length Papers

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- Convolutional Neural Networks for EEG Signal Classification in Asynchronous Brain-Computer Interfaces. Elliott M. Forney (2019) PhD Dissertation. Department of Computer Science, Colorado State University, Fort Collins, CO.
- Learning Deep Representations of EEG Signals in Mental-Task Brain-Computer Interfaces using Convolutional and Recurrent Networks. Elliott M. Forney (2017) Preliminary PhD Exam. Department of Computer Science, Colorado State University, Fort Collins, CO.
- Echo State Networks for Modeling and Classification of EEG in Mental Task Brain-Computer Interfaces. Forney, E., Anderson, C., Gavin, W., Davies, P., Roll, M., Taylor, B. (2015) Technical Report, Department of Computer Science, Colorado State University, Fort Collins, Colorado.
- Representing and Classifying EEG Signals in Mental Task Brain-Computer Interfaces. Elliott M. Forney (2013) Research Exam. Department of Computer Science, Colorado State University, Fort Collins, CO.
- EEG character identification using stimulus sequences designed to maximize minimal hamming distance. Fukami, T., Shimada, T., Forney, E., Anderson, C. *Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, August 28–September 1, 2012. pp. 1782–1785. 2012.
- Classification of EEG During Imagined Mental Tasks by Forecasting with Elman Recurrent Neural Networks. Forney, E. and Anderson, C. In *Proceedings of the International Joint Conference on Neural Networks*, July 31–August 5, 2011. pp. 2749–2755.
- Reliable identification of mental tasks using time-embedded EEG and sequential evidence accumulation. Anderson, C., Forney, E., Hains, D., Natarajan, A. *Journal of Neural Engineering*, April 2011, vol. 8, no. 2, 025023.
- Critical issues in state-of-the-art brain-computer interface signal processing. Krusienski, D., Grosse-Wentrup, M., Galan, F., Coyle, D., Miller, K., Forney, E., Anderson, C. *Journal of Neural Engineering*, April 2011, vol. 8, no. 2, 025002.
- Electroencephalogram Classification by Forecasting with Recurrent Neural Networks. Elliott Forney (2011) Masters Thesis, Department of Computer Science, Colorado State University, Fort Collins, CO.

## Conference Posters and Abstracts

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- Mental-Task BCIs Using Convolutional Networks with Label Aggregation and Transfer Learning. Forney, E., Anderson, C., Gavin, W. and Davies, P. *Seventh International Brain-Computer Interface Meeting: BCIs, Not Getting Lost in Translation*, May, 2018. Asilomar Conference Center, Pacific Grove, California, USA. *Abstract & Poster*.
- Detecting P300 ERPs with Convolutional Networks. Elliott M. Forney, Charles W. Anderson, Patricia L. Davies, William J. Gavin, Marla C. Roll. *Sixth International Brain-Computer Interface Meeting*, Asilomar California, May 30<sup>th</sup> – June 3<sup>rd</sup>, 2016. Graz University of Technology Publishing House. *Abstract & Poster*.
- CEBL<sub>3</sub>: A New Software Platform for EEG Analysis and Rapid Prototyping of BCI Technologies. Elliott M. Forney, Charles W. Anderson, William J. Gavin, Patricia L. Davies, Marla C. Roll, Igor Ryzhkov, Fereydoon Vafaei. *Sixth International Brain-Computer Interface Meeting*, Asilomar California, May 30<sup>th</sup> – June 3<sup>rd</sup>, 2016. Graz University of Technology Publishing House. *Abstract & Poster*.
- CEBL<sub>3</sub>: A Modular Platform for EEG Signal Analysis and Real-Time Brain-Computer Interfaces. Forney, E. and Anderson, C. Presented at the Front Range Neuroscience Group (FRNG) Annual Meeting, December 10<sup>th</sup>, 2014, Fort Collins, Colorado. Also presented at the Colorado State University Graduate Student Showcase, February 20<sup>th</sup>, 2015, Fort Collins, Colorado. *Abstract & Poster*.
- A Brain-Computer Interface for Controlling Mobile Robots. Elliott Forney, Igor Ryzhkov, Charles Anderson, William Gavin and Patricia Davies. Presented at the Frong Range Neuroscience Group (FRNG) Annual Meeting, December 9<sup>th</sup>, 2015, Fort Collins, Colorado. *Abstract & Poster*.

- A Stimulus-Free Brain-Computer Interface Using Mental Tasks and Echo State Networks. Forney, E., Anderson, C., Gavin, W., and Davies, P. *Fifth International Brain-Computer Interface Meeting: Defining the Future*, June 3 – 7, 2013. Graz University of Technology Publishing House. *Abstract & Poster - Winner of Best Poster Award.*
- The N100 of Averaged ERPs Predicts LDA Classifier Success on an Individual Basis. Brittany Taylor, Elliott Forney, William Gavin, Charles Anderson and Patricia Davies. *Fifth International Brain-Computer Interface Meeting: Defining the Future*, June 3 – 7, 2013. Graz University of Technology Publishing House. *Abstract & Poster.*
- A Comparison of EEG Systems for Use in P300 Spellers by Users With Motor Impairments in Real-World Environments. Elliott Forney, Charles Anderson, Patricia Davies, William Gavin, Brittany Taylor and Marla Roll. *Fifth International Brain-Computer Interface Meeting: Defining the Future*, June 3 – 7, 2013. Graz University of Technology Publishing House. *Abstract & Poster.*
- Overcoming Barriers in Noninvasive Brain-Computer Interfaces. Elliott Forney, Kathleen Ericson, Charles Anderson, Shrideep Pallickara, William Gavin, Patricia Davies, Marla Roll, Zachary Cashero. Summary of our research in Brain-Computer Interfaces for the g.Tec Brain-Computer Interfaces Competition. July 2012. *Competition Abstract.*
- Non-Invasive Brain-Computer Interfaces using Echo State Networks. Elliott Forney, Charles Anderson, William Gavin, Patricia Davies, Brittany Taylor and Marla Roll. Presented at the Front Range Neuroscience Group (FRNG) Annual Meeting, November 28<sup>th</sup>, 2012, Fort Collins, Colorado. *Abstract & Poster.*
- Modeling and Classification of EEG using Recurrent Neural Networks. Forney, E. and Anderson, C. Presented at the Fourth International BCI Meeting, May 31<sup>st</sup> – June 4<sup>th</sup>, 2010, Asilomar California. *Abstract & Poster.*

## Select Presentations

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- Regularly presented research findings to large audiences. Maxar Technologies. 2021–Present, Westminster, Colorado.
- Organizer, frequent presenter and host of the NLU Learning Guild. IBM Watson. 2018–2021, Denver, Colorado.
- EEG Signal Classification in Asynchronous BCIs A Journey from Time Embedding to Convolutional Networks. Presented at the Workshop on Deep Learning and other Machine Learning and Signal Processing Methods for Analyzing EEG in BCI Paradigms at The Seventh International BCI Meeting, June 1<sup>st</sup>, 2016, Pacific Grove, California. *Invited Speaker for Workshop.*
- Brain-Computer Interfaces: Demonstrations and Discussions of Applications. Anderson, C., Davies, P., Roll, M., Gavin, W., Forney, E. and Heffern, C. Presented at the Rehabilitation Engineering and Assistive Technology Society of North America (RESNA) Annual Conference, June 13<sup>th</sup>, 2015, Denver, Colorado. *Oral Presentation and Live Demonstration of a BCI system.*
- A Direct Brain-Computer Interface for Multimedia and Environmental Controls. Forney, E., Anderson, C., Gavin, W. and Davies, P. Presented at the Colorado State University Ventures Annual Meeting, April, 2015. Fort Collins, Colorado. *Selected Student Speaker & Competition Finalist.*
- A Brief Introduction to Brain-Computer Interfaces. Forney, E. Presented to a graduate course on human-computer interfaces, April, 2015. Department of Technical Journalism, Colorado State University, Fort Collins, Colorado. Also presented to a graduate course on assistive technology, April 10<sup>th</sup>, 2014. Department of Occupational Therapy, Colorado State University, Fort Collins, Colorado. *Invited Lecture.*
- Classification of EEG During Imagined Mental Tasks by Forecasting with Elman Recurrent Neural Networks. Forney, E. and Anderson, C. Presented at the International Joint Conference on Neural Network (IJCNN), August 5<sup>th</sup>, 2011, San Jose, California. *Selected Student Speaker.*
- Modeling and Classification of EEG by Forecasting with Recurrent Artificial Neural Networks. Forney, E.

and Anderson, C. Presented at the Front Range Neuroscience Group (FRNG) Annual Meeting, December 7<sup>th</sup>, 2011, Fort Collins, Colorado. *Selected Student Speaker & Competition Winner*.

## Open-Source Projects

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- notebooks: A collection of Jupyter notebooks demonstrating analyses and implementations for various problems related to machine learning, computer vision, brain-computer interfaces and high-performance computing. <https://github.com/idfah/notebooks>
- CEBL<sub>3</sub> (Colorado EEG and BCI Laboratory): *No longer maintained*. A modular, real-time Brain-Computer Interface system written primarily in Python. CEBL<sub>3</sub> is designed to support all phases of Brain-Computer Interface (BCI) research and development and includes a variety of standard and cutting-edge features for signal processing, machine learning, visualization and a fully functional graphical user interface for real-time BCI applications. <https://github.com/idfah/cebl>
- csuthesis (Colorado State University Thesis & Dissertation LaTeX Template): The official thesis and dissertation LaTeX template for Colorado State University. This software was developed under a grant from the CSU Graduate Student Council and is widely used. <https://github.com/idfah/csuthesis>
- ReGenerator (Re-Entrant Generator): A Python streaming container for data processing that supports lazy evaluation and repeated (reentrant) iteration. ReGenerator streams provide a powerful tool for building data processing pipelines and machine learning training routines that are able to work with datasets that are too large to fit into volatile memory. <https://github.com/ibm/regenerator>
- sshall: A simple but flexible tool for executing remote commands across multiple hosts. sshall works well with shell pipelines and supports parallel execution. <https://github.com/idfah/sshall>

## Honors and Awards

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- IBM Outstanding Technical Achievement Award (OTAA). I received this award in 2021 for my work on the design and implementation of a new, general-purpose, inner-source natural language processing library that is used by multiple teams and products at IBM.
- IBM Crush-IT Award. I received this award from IBM in 2020 for exceptional work related to the modernization of our general-purpose Named Entity Recognition (NER) system.
- IBM Agile Award. My squad, within the broader NLU team, received this award in 2018 for outstanding execution of Agile practices, especially for our work expanding the NLU service to support multiple new languages.
- Student Travel Award. I received this award, funded by the NSF and NIH, to attend and present my research at the 2016 International Brain-Computer Interfaces Meeting.
- Artificial Intelligence and Evolutionary Computation Fellowship. I received this fellowship award from the Colorado State University Computer Science Department in 2015 for excellence in research in the fields of machine learning and brain-computer interfaces.
- CSU Ventures Competition Finalist. I received this award for my selected oral presentation titled “BCI Player: A Direct Brain-Computer Interface for Multimedia and Environmental Controls” at the 2015 CSU Ventures Competition.
- Graduate School Excellence Award. I received this award for my poster presentation titled “CEBL3: A Modular Platform for EEG Signal Analysis and Real-Time Brain-Computer Interfaces” presented at the 2015 Colorado State University Graduate Student Showcase.
- Student Art Award. I received this award for my artwork titled “Energy” that I presented at the 2014 Front Range Neuroscience Group (FRNG) annual meeting in Fort Collins, Colorado.
- Best Overall Poster Award. I received this award for my poster presentation titled “A Stimulus-Free Brain-

Computer Interface using Mental Tasks and Echo State Networks” presented at the 2013 International BCI Meeting in Asilomar, California.

- Honorable Mention. I received this award for my artwork titled “Singular Figures” presented at the 2012 juried CSU Art and Science Exhibition in Fort Collins, Colorado.
- Best Student Presentation Award. I received this award for my oral presentation titled “Modeling and Classification of EEG by Forecasting with Recurrent Artificial Neural Networks” presented at the 2011 Front Range Neuroscience Group (FRNG) annual meeting in Fort Collins, Colorado.
- 1<sup>st</sup> Place in Computer Science. I received this award for my performance in the Western Nebraska Interscholastic Competition while I was a senior in high school in 2000. This award included an offer for a full academic scholarship to Chadron State College in Nebraska.

## **Certifications**

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- Import and Export Controls Training - Maxar Technologies, January 2024.
- Data Privacy Training (HIPAA & GDPR) - IBM, 2018, 2019, 2020.
- Watson and Cloud Foundations - IBM, Watson Academy, May 2019.
- Machine Learning with Python - IBM, Cognitive Class, September 2019.
- Python for Data Science - IBM Cognitive Class, September 2019.
- Human Subjects Protection - Colorado State University, CITI Training, January 2015.
- Responsible Conduct for Research - Colorado State University, August 2012.

## **Professional Associations**

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- Faculty Affiliate, Colorado State University, Department of Computer Science. I continue to work with my graduate advisor, Dr. Charles Anderson, to maintain web sites, data sets and to continue ongoing research related to brain-computer interfaces and machine learning.
- Member of IEEE.
- Member of the IEEE Computational Intelligence Society.
- Reviewer for various journals and conferences, including the International Joint Conference on Neural Networks (IJCNN), IEEE Transactions on Neural Networks and Learning Systems (TNNLS), Engineering Applications of Artificial Intelligence (EAAI), IEEE Symposium Series on Computational Intelligence (SSCI), IEEE International Conference on Tools with Artificial Intelligence (ICET), IEEE Transactions on Control Systems and Technology and Connection Science.
- Selected member and former officer of the CSU Beta Chapter of The Upsilon Pi Epsilon (YPIE) Computer Science Honor Society.
- Former student member of the CSU Molecular, Cellular and Integrative Neuroscience (MCIN) group.