

Jacob Rafati

Electrical Engineering and Computer Science
Computational Cognitive Neuroscience Lab
University of California, Merced
5200 N Lake Rd, Merced, CA, 95343

Cell Phone: +1 415 964 8086
yrafati@gmail.com
jrafatiheravi@ucmerced.edu
<https://github.com/root-master>

RESEARCH & DEVELOP-
MENTS INTERESTS

- ◇ Machine Learning
- ◇ Large-scale Numerical Optimization
- ◇ Deep Learning
- ◇ Computer Vision
- ◇ Reinforcement Learning
- ◇ Approximation Algorithms Design and Analysis
- ◇ Dynamical Systems and Control
- ◇ Applied Mathematics
- ◇ Optimization and Matrix Analysis

EDUCATION

- ◇ **University of California, Merced**, Merced, CA (Fall 2013 – Present)
Ph.D. Student in Electrical Engineering and Computer Sciences, **GPA to date: A.**

RECENT PROJECTS

- ◇ **State Representation in Reinforcement Learning, Ph.D. Thesis** (2014-now)
Reinforcement Learning is a framework for an *agent* that learns to solve a task thru interaction with *environment* to reach to a *goal* or accomplish a *task*. It's useful oftentimes to divide the task to several subtask and learn how to solve the task with choosing the optimal subtasks i.e. Hierarchical Reinforcement Learning. Finding these *subtasks* or *subgoals* are still an open problem in AI. We are introducing unsupervised methods such as auto-encoders, to develop efficient and general models to categorize Reinforcement Learning *agent's* state space to small set of *subgoals* in order to reduce the dimensionality of state space. We employ Hierarchical Reinforcement Learning methods and other heuristic search algorithms to find an optimal solution. We will test the efficiency of our model with the empirical experiments on the current challenging control problems with high dimensional state space such as ATARI games (image), Go games and Self-driving Cars (image and other sensors). The codes for this ongoing project is implemented in Python using TensorFlow and is available in: <https://github.com/root-master/unsupervised-reinforcement-learning>
- ◇ **Model Compression in Deep Neural Networks with Application in Mobile Devices** (2017)
Implementation of **model-compression** algorithm from <https://arxiv.org/abs/1707.04319>. I am using model compression as constrained optimization to quantize the weights of Deep Neural Networks from a adaptive codebook (weights are chosen from a trainable codebook). This guarantees to converge to local optimum of the loss. The compressed CNN models will be tested on mobile devices. The codes for this ongoing project is implemented in Python using TensorFlow and is available in <https://github.com/root-master/deep-compress>.
- ◇ **Second Order Optimization in Deep Learning: Towards Robust Convergence** (2017)
I am using second order optimization methods which are using the Hessian Matrix and Quasi-Newton methods, like L-BFGS and Trust Region methods to develop an efficient second order algorithm for large-scale deep learning optimization problem. I support the theoretical claims with empirical experiments on classification of MNIST hand-written dataset.
The codes for this ongoing project is implemented in Python using TensorFlow and is available in <https://github.com/root-master/deep-newton>.
- ◇ **Sparse Coding of Learned State Representations in Reinforcement Learning** (2014-2015)
Inspired by the lateral inhibition in the cortex, we used k-Winner-Take-All mechanism in *Temporal Difference* Learning to produce sparse distributed internal representations of agent's state which leads

to the better convergence of value function and policy mapping in problematic control tasks such as puddle world, mountain car and acrobat. he codes is implemented in **Matlab** and also **Python** using **TensorFlow** and is available in <https://github.com/root-master/deeptd>.

◇ **Live MNIST (2016)**

Implementation of Deep Convolutional Neural Net using **Keras** and **TensorFlow** as backend for live classification using **opencv**. Code is available in <https://github.com/root-master/live-mnist>.

- PUBLICATIONS ◇ Jacob Rafati, Omar DeGuchy and Roummel F. Marcia. “Trust-Region Minimization Algorithm for Training Responses (TRMinATR): The Rise of Machine Learning Techniques”, *2018*, 26th European Signal Processing Conference (EUSIPCO 2018), Rome, Italy.
- ◇ Jacob Rafati, David C. Noelle. “Sparse Coding of Learned State Representations in Reinforcement Learning”, *2017*, Cognitive Computational Neuroscience Conference, Newyork City, NY.
- ◇ Jacob Rafati, David C. Noelle “Lateral Inhibition Overcomes Limits of Temporal Difference Learning”, *2015*, 37th Annual Cognitive Science Society Meeting, Pasadena, CA.
- ◇ Jacob Rafati, Mohsen Asghari and Sachin Goyal. “Effects of DNA Encapsulation On Buckling Instability of Carbon Nanotube based on Nonlocal Elasticity Theory”, Proceedings of the ASME 2014 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, IDETC/CIE 2014. August 17-20, 2014, Buffalo, New York, USA.
- ◇ Mohsen Asghari, Jacob Rafati and Reza Naghdabadi, “Torsional instability of carbon nano-peapods based on the nonlocal elastic shell theory”, *Physica E: Low-dimensional Systems and Nanostructures*, 2013. 47: p. 316-323.
- ◇ Mohsen Asghari M, Reza Naghdabadi, and Jacob Rafati. “Small scale effects on the stability of carbon nano-peapods under radial pressure”, *Physica E: Low-dimensional Systems and Nanostructures*, 2011. 43(5): p. 1050- 1055.
- ◇ Mohsen Asghari, Jacob Rafati. “Variational Principles for the Stability Analysis of Multi-Walled Carbon Nanotubes Based on a Nonlocal Elastic Shell Model”, ASME 2010 10th Biennial Conference on Engineering Systems Design and Analysis (ESDA2010), Paper no: ESDA2010-24473 pp. 591-598.

TEACHING
EXPERIENCE

- ◇ **Graduate Student Teaching Assistant**
- Artificial Intelligence
 - Computational Cognitive Neuroscience
 - Introduction to Computer Science and Engineering I & II

TECHNICAL
SKILLS

- ◇ Programming Languages: **Python**, **MatLab**, **Java**, **C++**, **Bash**.
- ◇ Machine Learning Libraries: **TensorFlow**, **Keras**, **scikit-learn**, **Torch**.
- ◇ Web Development: Front-end and Back-end, **NodeJS**, **HTML**, **CSS**, **JavaScript**, **expressjs** and **expressjs**.
- ◇ Database Systems: **NoSQL MongoDB**.
- ◇ Designing Deep Neural Network, architecture, algorithm design, running on clusters and GPU and Data Analysis.
- ◇ Designing and analysis of recent methods in machine learning and deep learning such as Generative Adversarial Networks and Recurrent Neural Networks.
- ◇ High understanding of algorithms
- ◇ High understanding of Linear Algebra, Numerical Analysis, Optimization, Topology, Graph, Statistics, Probability, Dynamical Systems.
- ◇ Probabilistic Robotics.
- ◇ Web Application Automatic Testing: with **Selenium** API for **Python**.
- ◇ Approximation Algorithm design and analysis.
- ◇ Search Algorithms in Artificial Intelligence.

SOCIAL SKILLS ◇ High communication and organization skills.

◇ Problem Solving and collaborative mindset and high skills in teamwork.

◇ Innovation and creativity.

◇ Passion for managing projects and finding new sub-problems.