Jonathan Mitchell

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About

I'm a current PhD CS student at UCLA with a focus in Computer Vision and Pattern Recognition. My interests lie at the intersection of Computer Vision and Security - providing security defenses in safety critical AI systems including Facial Recognition and Autonomous Driving. I was previously a Computer Vision engineer @Octi.tv where I worked extensively on human pose estimation, instance segmentation, and gesture recognition by training neural networks to perform those tasks.

Technical Skills

Science: C • C++ • Python • Caffe • Keras • Tensorflow • OpenCV • MATLAB • Arduino/RaspberryPi/Tiva • Solidworks • NumPy • SciPy • CUDA • Pandas • Scikit-learn • Linux • R • HFSS
Full-Stack: JavaScript (jQuery, Angular, React, Redux, Backbone, ES6, ES7) • HTML5/CSS3 • Angular • Sass MySQL • NodeJS • MongoDB • KnexJS • Grunt • Gulp • Babel • Heroku • Git • MongodB • TDD/Mocha/Jasmine
Deep Learning: Decision Trees • Convolutional Neural Networks • Object Detection • Semantic Segmentation • Scene Understanding • Numerical optimization for mobile integration (iOS)

Research

Stochastic Security: Adversarial Defense Using Long-Run Dynamics of Energy-based models   07/04/2020
- **https://arxiv.org/abs/2005.13525** submitted to ICLR2021.
- Constructed State of the Art Adversarial Defense preprocessing algorithm without adversarial training 55.5 acc

Instance Segmentation: Bounding Box and Pose Detection combined   07/2018 - 09/2018
- Added a human pose detection branch to an existing Bounding Box Embedding network in order to predict human pose and instance masks in the wild. Achieved mAP@IoU=50 = 0.559 on Microsoft MSCOCO keypoint detection task and AP@IoU=50 = 0.338 on COCO Instance Segmentation benchmark.
- Re-designed data generation in order to include human keypoints, wrote entire code base: designed, trained, and tested on Microsoft's COCO dataset.
- Network is mobile-ready and can run in real time on an iPhoneX's GPU.

Bounding Box Embedding for Single Shot Person Instance Segmentation   06/2018 - 07/2018
https://arxiv.org/abs/1807.07674
- Wrote and designed the training pipeline, loss functions, data generation, evaluation. Trained and benchmarked on the COCO dataset. Implemented using Keras and Tensorflow.
- Implemented several different network architectures during training. Encoders include ResNet50, ResNet101, MobileNet, MobileNetV2 and decoders include U-Net, DeepLabV3+, and naive upsampling.
- Built Atrous Spatial Pyramid pooling layers in order to increase semantic information flow while maintaining receptive field view between our encoder and decoder
- Achieved 0.374 AP on the Person class compared to PersonLab's 0.382 AP, and our network is mobile ready

Semantic Instance Segmentation via Metric Learning: **03/2018 - 04/2018**
- Created a neural network that branches off of a Convolutional Pose Machine to identify individual instance masks in an image
- Network is based on metric learning with a discriminative loss function that decodes semantic instances of humans and is able to identify individual human masks in a scene
- This network is different and an alternative to Mask-RCNN implementations and it's able to run on mobile (iOS)
- Designed a contrastive loss function and an encoding – decoding pipeline using RMPE server, Keras, and Tensorflow

Mobile-Mask-RCNN: **04/2018 - 06/2018**
- Created a mobile-optimized version of Mask-RCNN by swapping out ResNet50 and using a MobileNet V1 or MobileNet V2 backbone network with depthwise-separable convolutions and inverted residual blocks.
- Reduced computation time to 0.07s at inference on an Nvidia Geforce Gtx 1080Ti.
- Created Feature Pyramid Network, custom ROI Alignment layers, hyper parameter tuning, mobile quantization, and weights pruning
- Project implemented using Tensorflow and Keras

Human pose:
Deep3D: Human skeletal 2D -> 3D reconstruction network for depth and missing joint inference   **10/2017**
- Created a synthetic data generation pipeline to select virtual cameras for perspective projection locations and generate indefinite amounts of training data using the Panoptic pose dataset and the Human3.6M dataset
- Designed and implemented the network's preprocessing and postprocessing pipeline using Numpy, OpenCV, and Keras

2D human joint detection networks: **09/2017**
- Optimized Convolutional Pose Machines that take an image as input and extract human 2D joints
- Utilized depthwise-separable convolutional layers for network compression and mobile GPU optimization, achieving a15x computation reduction
- (in progress) Implement custom deformable convolutional layers and deformable RoI pooling layers for high GPU utilization and Tensorflow integration

Scene recognition:
Deep Depth: **02/2018**
- Design a neural network to produce depth maps from indoor scenes in order to reject background noise when performing human pose detection
- Implement a multi-scale neural network that uses global context, gradient estimation, and refined feature smoothing for depth estimation in Keras

Breast Cancer Analysis: Malignant vs. Benign classifier | link: http://bit.ly/2yzgICS   **05/2017**
- Extracted viable features such as smoothness, radius, symmetry, compactness and fractal dimensionality and trained machine learning models to predict whether a certain breast cancer tumor is malignant or benign
- Benchmarked and trained Naïve Bayes, SVM, and Decision Tree classifiers
- Obtained 92% accuracy on class predictions using a support vector machine

Education

Doctor of Philosophy: Computer Science   **09/2018 - Present**
University of California, Los Angeles   **Los Angeles, CA**
Focus in Computer Vision and AI Security

Masters of Science: Computer Science   **09/2018 - 06/22/2020**
University of California, Los Angeles   **Los Angeles, CA**
Focus in Computer Vision and Pattern Recognition

Self-Driving Car Engineering Nanodegree   **11/2016 - 08/2017**
Udacity   **Mountain View, CA**

Advanced Software Engineering Immersive   **06/2016 - 10/2016**
Hack Reactor   **Los Angeles, CA**

Bachelor of Science: Electrical Engineering   **09/2015 - 12/2015**
University of California, Davis   **Davis, CA**
Focus in signal processing and microwave engineering

Work Experience

Intern - Autonomous Driving   **06/2020 - 09/2020**
Nvidia   **Santa Clara, CA**
- Shadow mode active learning loop for Nvidia drive platform
- NCAP validation for perception based systems for verification and robustness

Graduate Student Researcher   **07/2019 - Present**
UCLA Center for Vision Language Cognition and Autonomy   **Los Angeles, CA**
- Member of VCLA research group working on Computer Vision, Energy Modeling, MCMC, AI Security

Computer Vision Engineer   **06/2017 - 09/2018**
SuperMediaFuture dba Octi Inc. | link: http://www.octi.tv   **Los Angeles, CA**
- Implement, design, and experiment with deep neural networks using Caffe, OpenCV, Tensorflow, and Keras
- Focus on Instance Segmentation, Human Pose estimation and 3D reconstruction. (research section above)
- Research, design and optimize 3D reconstruction networks for mobile (iOS)
- Design, train, and test metric-based instance segmentation networks to extract individual segmentation masks for each human in an image. This is a non-bounding box approach that utilizes pixel embeddings and an encoding – decoding network with a discriminative loss function (different from mask rcnn). This network is also optimized for mobile integration (iOS).

Research Volunteer   **03/2017 - 05/2017**

University of Southern California   **Los Angeles, CA**
- Focus on unsupervised and semi-supervised learning, object segmentation and convolutional network design

Technical Mentor   **12/2016 - 06/2017**
Udacity   **Los Angeles, CA**
- Technical mentor providing support to 17 students in Udacity's Self-Driving Car Nanodegree program

Science Tutor   **11/2016 - 05/2017**
Hayutin Associates   **Los Angeles, CA**
- Math, physics, and programming tutor for high school and college students

Founder   **01/2016 - 07/2016**
Pushlens   **Los Angeles, CA**
- Invented a contact lens insertion device so individuals can insert contact lenses without having to physically touch them
- Designed product in Solidworks, performed extensive flow simulation, stress testing and 3D printed prototypes

Automation Engineering Intern   **06/2015 - 09/2015**
Genentech   **Oceanside, CA**
- Increased batch checking precision and efficiency through improving gas chromatography review tools

Software Development Engineering Intern   **06/2014 - 09/2014**
inSightec
- Created algorithms that contributed towards Parkinson's tremor's cure through designing a feedback control system that monitors an MRI-guided focused-ultrasound wave during a neurosurgical procedure
- Designed control system for real-time simulation of musculoskeletal responses in MATLAB

Open Source

Contributor
Keras team | link: https://keras.io/   **05/2017**
- Official implementer of MobileNetV2 (https://arxiv.org/abs/1801.04381) for Keras. MobileNetV2 is a very light weight general backbone network that can be used for various tasks such as object localization, classification, and segmentation. It has been pre-trained on imagenet.
- MobileNetV2 dramatically reduces both parameter count and computational cost. Specifically, for the task of object detection on ImageNet dataset, MobileNetV2 has 0.8M fewer params and outperforms MobileNetV1 by 0.6 %.
- Network was merged on 05/07/2018 (#10047) and can be found under keras_applications: https://github.com/keras-team/keras-applications/blob/master/keras_applications/mobilenet_v2.py

More Projects

Vehicle and Lane Line Detection | vehicle-repo: http://bit.ly/2qTMlrG lane-repo: http://bit.ly/2oK2hjj   03/2017
Detects vehicles and lane lines from a video stream using a support vector machine and computer vision techniques

- Designed cell-based window search method to extract image features and predict vehicle locations using OpenCV
- Implemented adaptive color thresholds, filtering, windowing, and morphological operations to detect lane lines

Speed Estimation – ML Eng | http://bit.ly/2n9gPwQ | github.com/jonathancmitchell/speedchallenge   03/2017

Neural network dashboard cam speed estimator for autonomous vehicles trained on 8616 images extracted from a video

- Utilized dense optical flow analysis and architected conv-net processing pipeline to achieve MSE of ~5.6

Behavioral Cloning – Self-Driving Car Engineer | http://bit.ly/2mblzxl   **02/2017**

Trained a model to simulate a self-driving car by predicting steering angles while driving in a unity simulation

- Normalized a multi-modal data distribution by performing data augmentation and creation
- Created a creative preprocessing pipeline with brightness augmentation, vertical flipping, resizing and cropping

Traffic Sign Classification – Machine Learning Engineer | http://bit.ly/2kkFlzN   **01/2017**

Classify Traffic Signs from more than 40 classes in a German Traffic Sign Dataset of 50,000 32x32 images

- Implemented a LeNet-like CNN using Google's Tensorflow deep learning framework
- Utilized normalization, data creation, regularization methods to increase accuracy to ~ 94.5% at test using Tensorflow

GamesReviewAPI – Full Stack Engineer | https://gamereviewdocs.herokuapp.com/   **11/2016**

A restful API that allows users to search through 18k game reviews and query for top scores by genre, platform, and title

● Designed ES7 generator functions to synchronously seed the database with 18k row entries

Radar Sensor – Electrical Engineer | http://bit.ly/2fNKu9w   **02/2014 - 06/2014**

24 Ghz Radar sensor to detect real time speed and range measurement

● Programmed a micro-processor to control a patch antenna array and transmit signals to antenna transceiver

Conferences Attended

Computer Vision and Pattern Recognition   **06/2018**
Computer Vision Foundation   Salt Lake City, Utah
AI Vision | link: http://ai.vision/   **03/2017**
AI By The Bay   San Francisco, CA
Self-Driving Cars | link: http://self.driving.cars/   **03/2017**
AI By The Bay   San Francisco, CA
TechCrunch Disrupt   **09/2015**
TechCrunch   San Francisco, CA
TechCrunch Disrupt   **09/2014**
TechCrunch   San Francisco, CA

Leadership

Founder and Lecturer   **01/2017 - Present**
Self-Driving Cars Los Angeles | meetup.com/Los-Angeles-Self-Driving-Car-Meetup/   **Los Angeles, CA**
● Prepare and present lectures on machine learning, computer vision, and image processing to 385 members
Student Body Senator   **12/2014 - 12/2015**
Associated Students Of University of California Davis   **Davis, CA**
● Oversaw 26 student-run businesses on campus and held responsibility over all revenues and property
● Co-managed an annual 11.8M budget and merged two student-run businesses to save another
● Administrated hiring efforts and conducted interviews for over 20 student-run business managers
President   **09/2014 - 03/2015**
Society of Biological Engineers at UC Davis   **Davis, CA**
● Managed club related finances, facilitated meetings and increased membership from 28 to 53 members