Applications in Artificial Intelligence/Machine Learning

Moderated by:
Dr. Frank A. Gomez
Executive Director, STEM-NET
Office of the Chancellor

STEM-NET

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Applications in Artificial Intelligence/Machine Learning

Speakers

Ilmi Yoon, San Francisco State
Machine Learning Enhanced Video Accessibility for Visually Impaired Users

Mohammad Pourhomayoun, Cal State LA
Artificial Intelligence: From Science Fiction to Real Life with Case Studies in Healthcare

Jonathan Ventura, Cal Poly San Luis Obispo
Adventures in Deep Learning: Learning to Predict Depth in Panoramic Video and Count Trees in Remote Sensing Data

Xiaorong Zhang, San Francisco State
Toward the Next-Generation Neural-Machine Interfaces for Neurorehabilitation

Jongwook Woo, Cal State LA
Introduction to Big Data and AI for Data Analytics and Prediction

Franz Kurfess, Cal Poly San Luis Obispo
Artificial Intelligence and Human-Computer Interaction in Class-Based Projects

Reza Akhavian, San Diego State
Artificial Intelligence in Construction Engineering

Frank A. Gomez *CSU Office of the Chancellor* *fgomez@calstate.edu*

Machine Learning enhanced Video Accessibility for Visually Impaired Users

Ilmi Yoon – San Francisco State Univ.

Collaborators: Pooyan Fazli (SFSU,CS), Shasta Ihorn (SFSU, Psychology), Charity Cooper (SKERI) Yue-Ting Siu (SFSU, Special Ed), Beste Yuksel (USF), Joshua Miele (Amazon), Abhishek Das (Facebook), Yash Kant (Georgia Tech)

Students (Alumni): Aditya Bodi, Andrew Scott*, Brenna Tirumalashetty, Jianfei Zhao*, Jose Castanon, Lothar Narins, Manish Patil, Poorva Rathi*, Rupal Kilarri*, Umang Mathur*, Vaishali Bisht*, Varun Sura*

Ilmi Yoon, Professor

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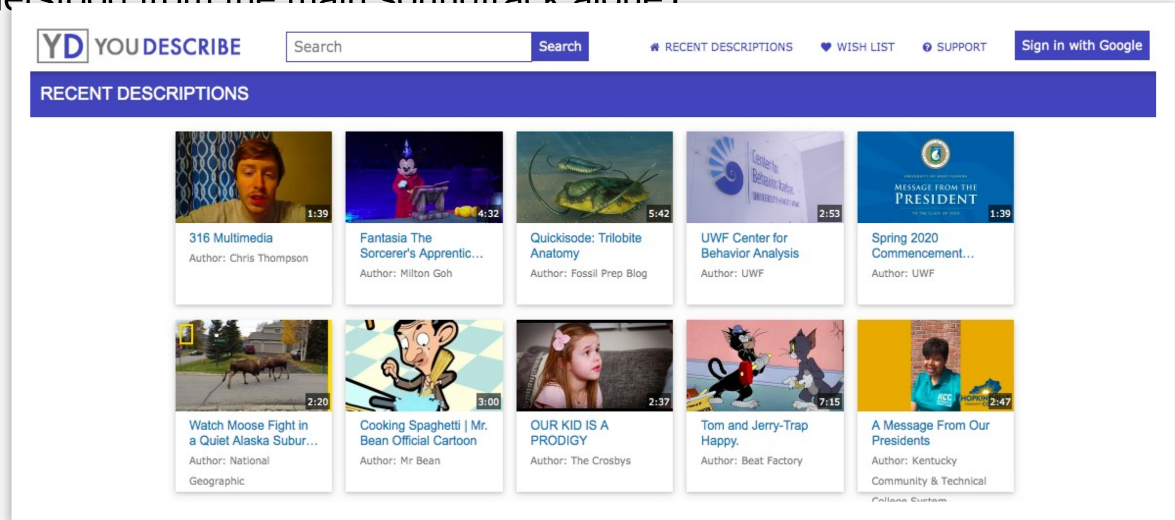
San Francisco State University

Machine Learning Enhanced Video Accessibility for Visually Impaired Users

Project Overview

- Problem: Video Accessibility for Visually Impaired users
  - WHO estimates that 285 million people worldwide are visually impaired, and 39 million are blind.
  - Video has become essential for education, entertainment, or social connections.
- Solution: Video/audio description (narration added to the soundtrack to describe important visual details that cannot be understood from the main soundtrack alone)



https://youdescribe.org/

Project Overview

- Challenge:
  - Difficulty in producing audio description
    - Cognitive load
    - Time
    - Tedious tasks
  - Can’t catchup to the speed of the video production.
    - 300 hours of video are uploaded to YouTube every minute! Almost **5 billion videos** are watched on YouTube every single day.
  - ~93% of the wish list videos in YouDescribe have no descriptions

State of Art ML: Image caption generation (Vision + NLP)

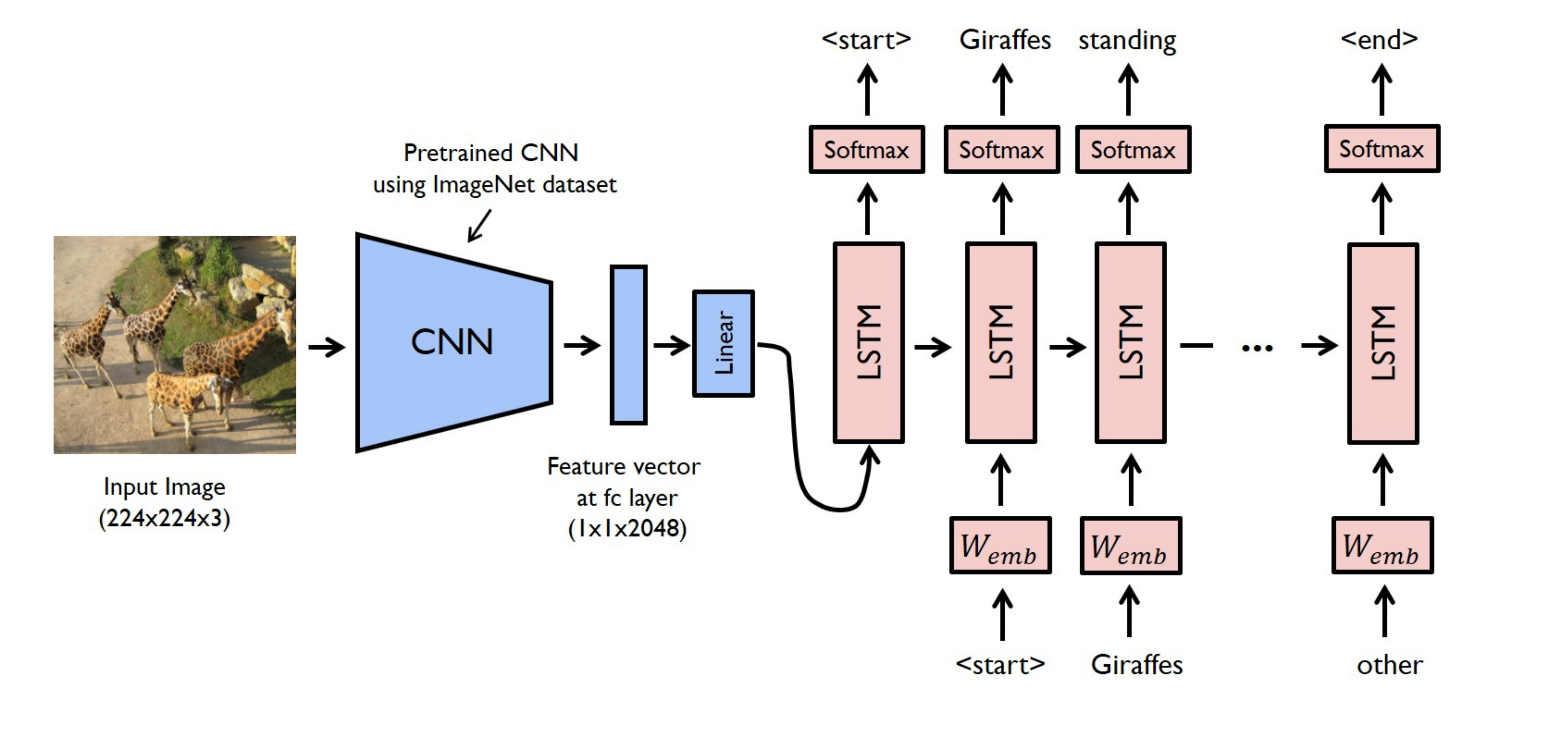
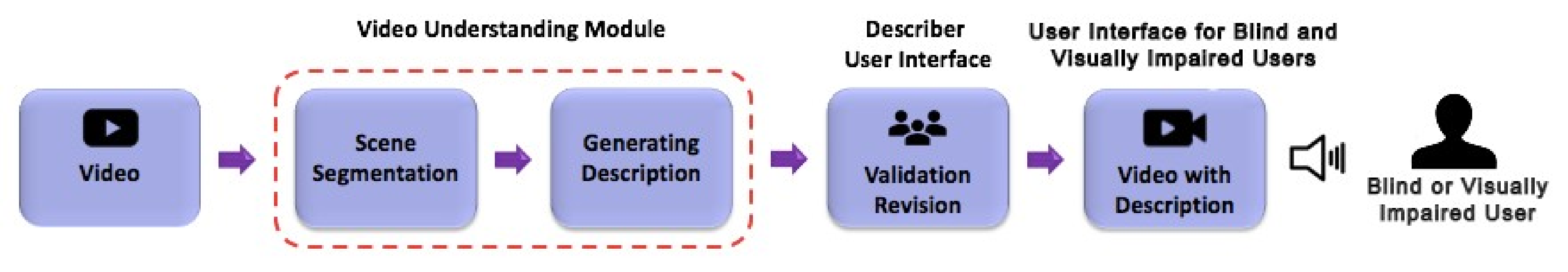


Image credit to https://www.markiiisys.com/blog/does-microsoft-word-use-deep-learning/

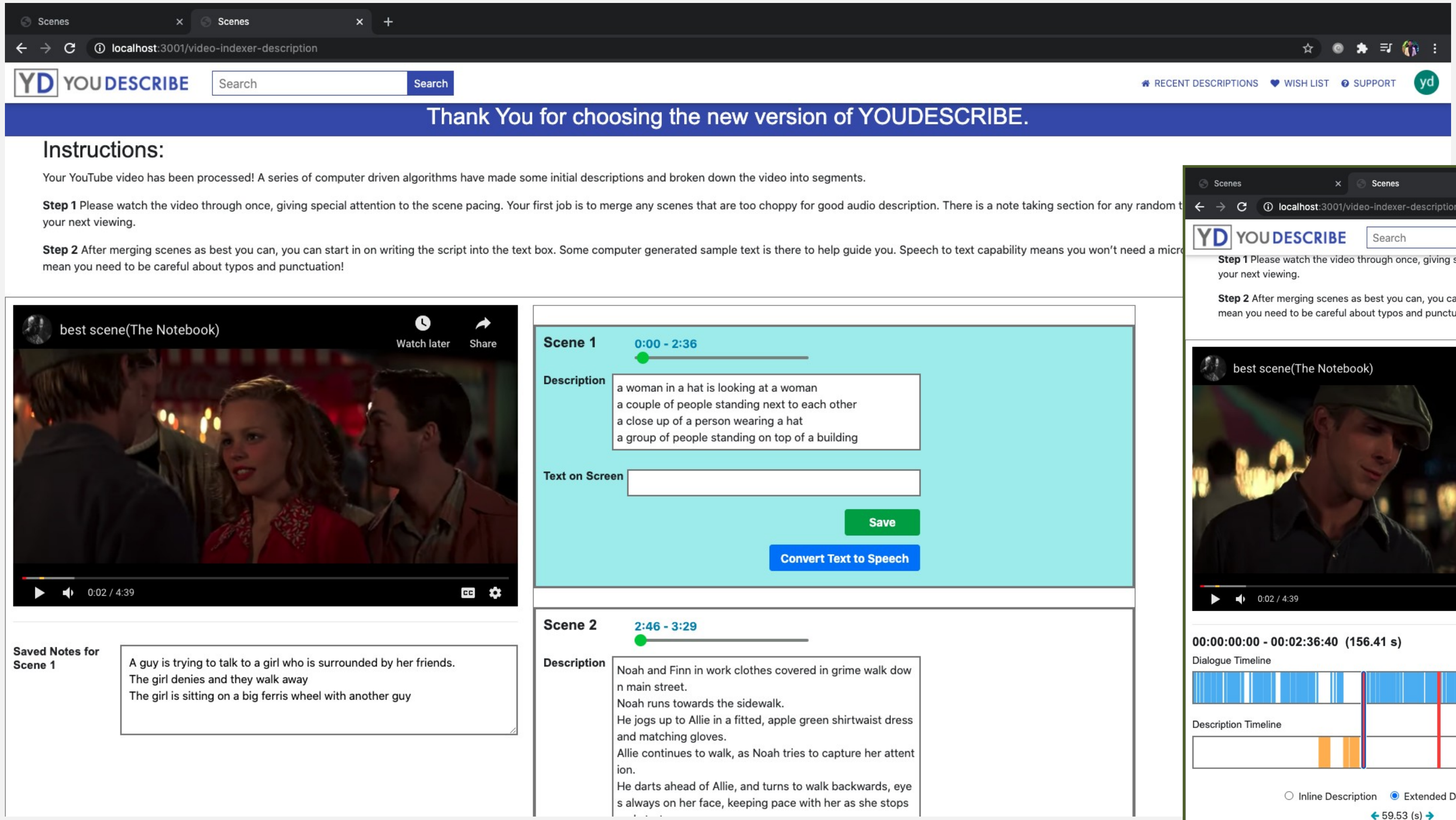
Activities – Support Baseline description generation

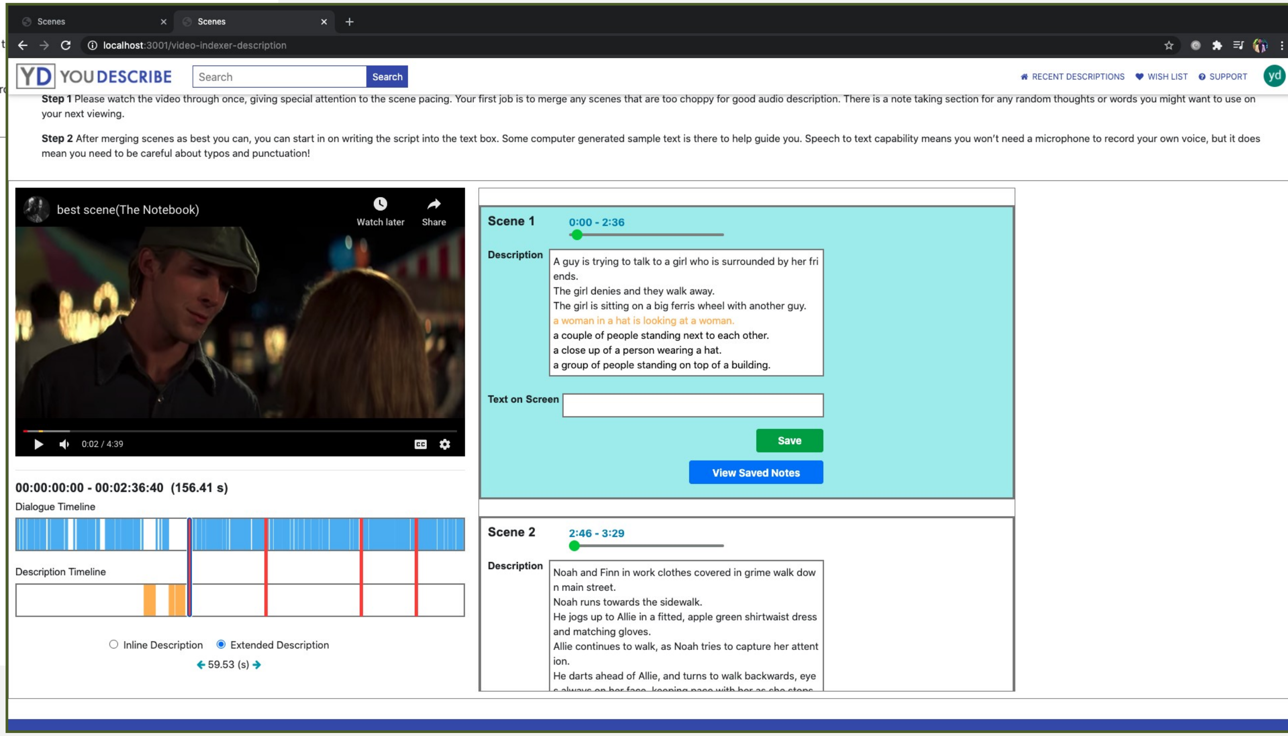
- **Baseline description**
  - Automatically read-out
    - Summary of visual contents
    - Texts-on-screen
    - Inline (plays over background music or quiet moments) or Extended (pause video and read out as there is no sufficient gaps to insert the audio description)
  - AI supported system produces :
    - Scene segmentations
    - Texts-on-screen



Machine Learning Enhanced Video Accessibility for Visually Impaired Users

Activities – Interfaces for Sighted Volunteers

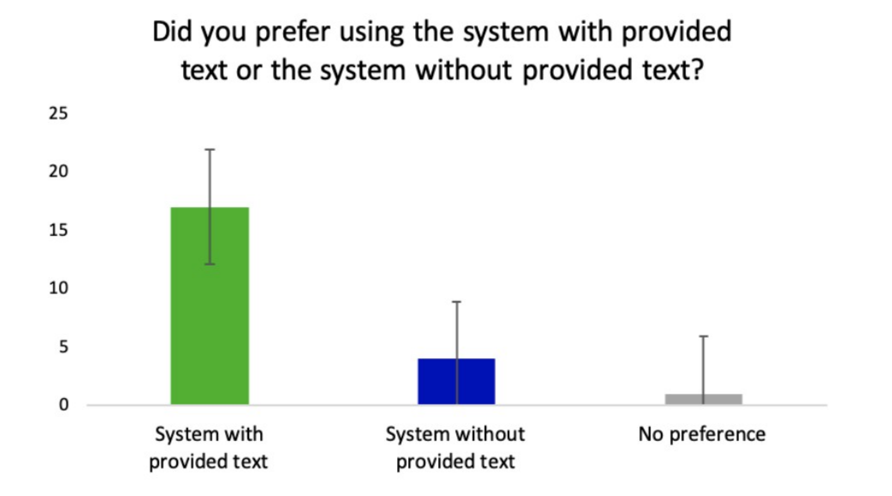


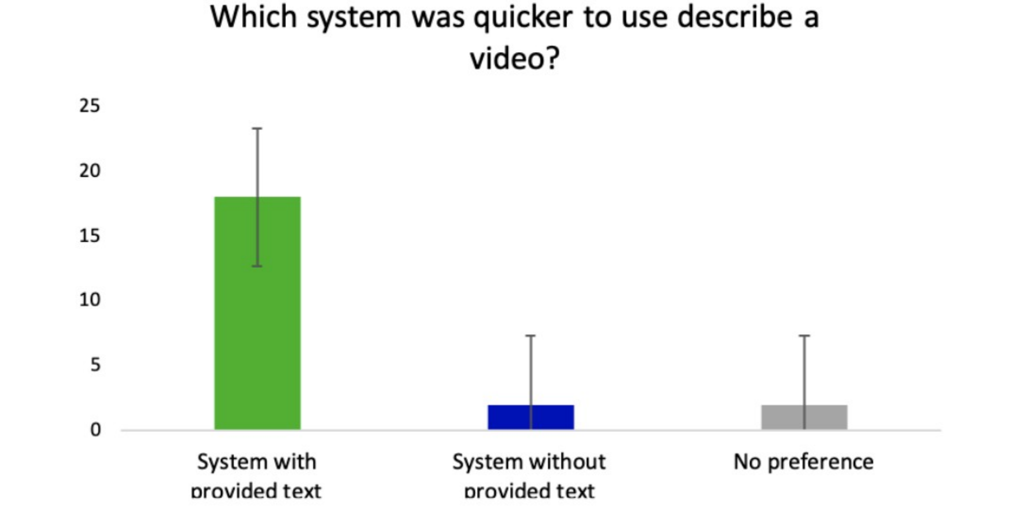


Machine Learning Enhanced Video Accessibility for Visually Impaired Users

Results

- Experiment 1 (Sighted Volunteers): We investigated the use of the AI-supported system in description generation for novice describers.
- Experiment 2 (VI users): We asked blind and visually impaired participants to rate the videos created by the describers in Experiment 1.





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State of Art ML: Visual Dialog (On demand description)

- Visually Impaired users can control when and what.

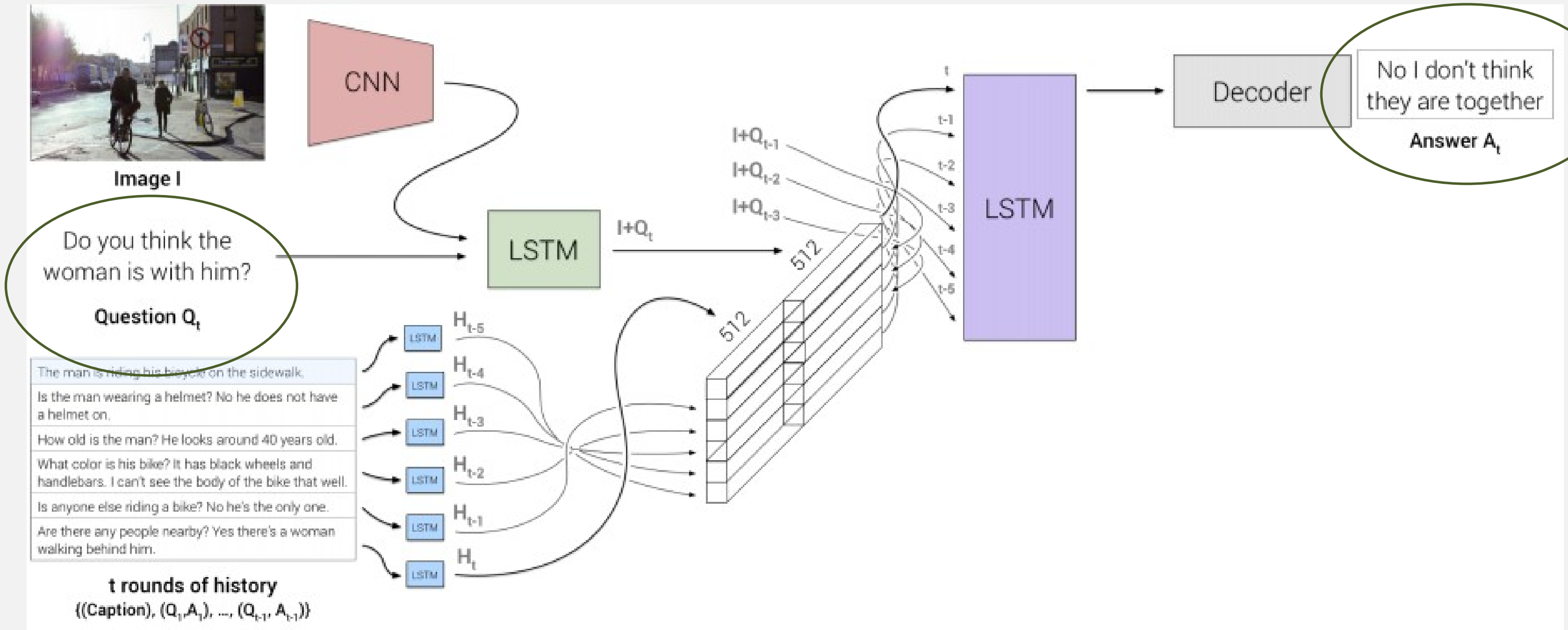
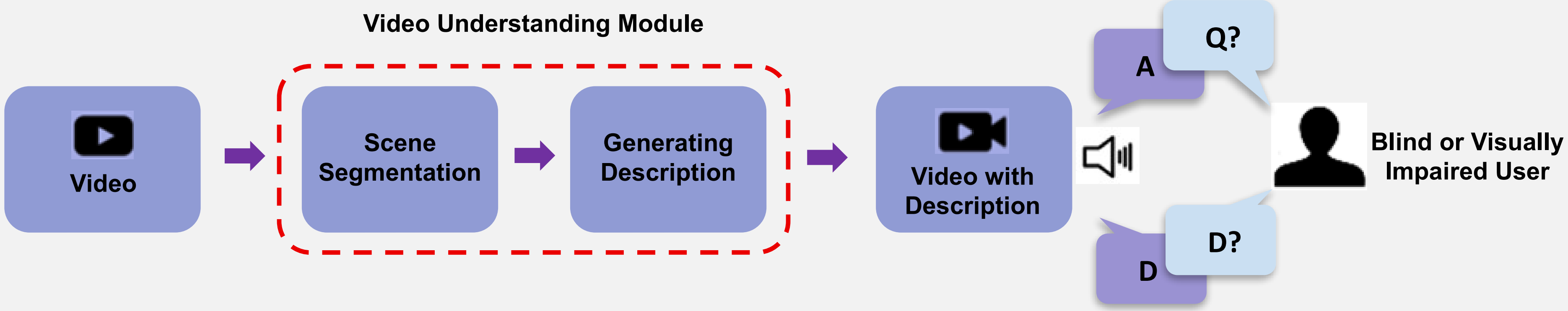


Image credit to Das et al at Visual Dialog paper, CVPR 2017

Activities – On Demand (Infobot)

- Design and develop an interactive way that VI users can control the level and content of descriptions
- Infobot (“D” key) – an image description is given upon request
- Infobot (“Q” key) – users can ask questions and continue dialog about visual content.



(Video) Demo of Infobot and AI Baseline Description

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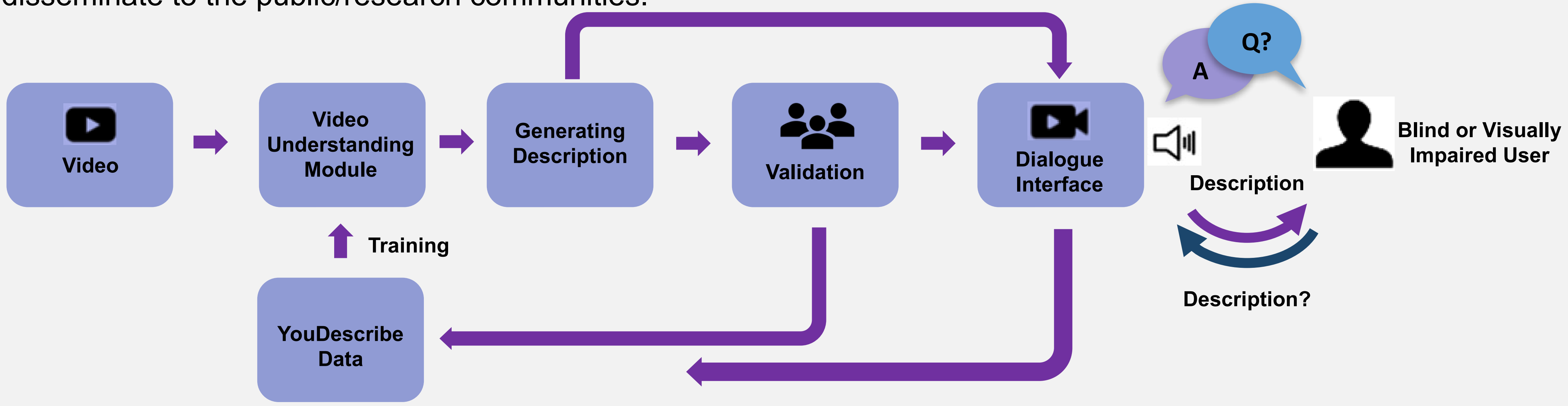
Next Steps/Long-Term Plans

- Integration of the AI-supported system into YouDescribe has now created YouDescribeX
- Improve accuracy by “Image caption generation → Video caption generation”
- Image caption generation → Image caption generation specifically for visually impaired users
- Compiles standardized, well-structured, open-source datasets to improve the machine learning models and disseminate to the public/research communities.



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Machine Learning Enhanced Video Accessibility for Visually Impaired Users

Acknowledgement

ABILITY CENTRAL
Sharing ideas, improving access.

Innovate@calstate.edu, AWS credit
California State University Office of the Chancellor

1. Beste F. Yuksel, Pooyan Fazli, Umang Mathur*, Vaishali Bisht*, Soo Jung Kim*, Joshua Junhee Lee*, Seung Jung Jin*, Yue-Ting Siu, Joshua A Miele, Ilmi Yoon, "Human-in-the-Loop Machine Learning to Increase Video Accessibility for Visually Impaired and Blind Users" accepted to present at ACM DIS 2020.
2. Beste F. Yuksel, Pooyan Fazli, Umang Mathur*, Vaishali Bisht*, Soo Jung Kim*, Joshua Junhee Lee*, Seung Jung Jin*, Yue-Ting Siu, Joshua A Miele, Ilmi Yoon, "Increasing Video Accessibility for Visually Impaired Users with Human-in-the-Loop Machine Learning", ACM CHI Extended Abstracts 2020 In Press
3. Ilmi Yoon, Umang Mathur*, Brenna Gibson Tirumalashetty*, Pooyan Fazli, Joshua Miele, "Video Accessibility for the Visually Impaired", In Proceedings of the Workshop on AI for Social Good at the International Conference on Machine Learning, ICML, Long Beach, CA, USA, 2019.

Artificial Intelligence: From Science Fiction to Real Life with Case Studies in Healthcare

Mohammad Pourhomayoun – California State University, Los Angeles

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Overview

amazon

Online Shopping
and Advertisements

Speech Recognition and
Natural Language Processing

Marketing

Computer Vision

Recommendation Systems

Self-Driving Cars

Healthcare

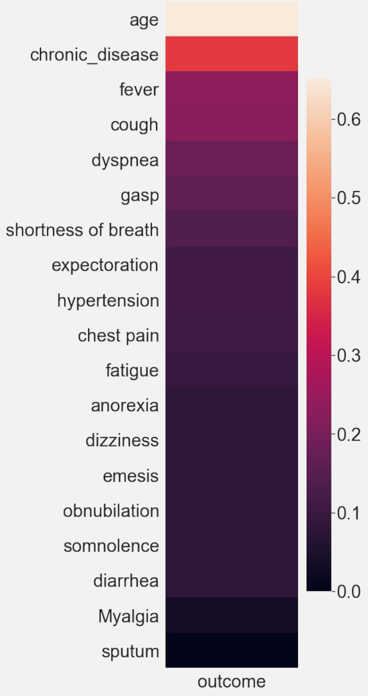
facebook

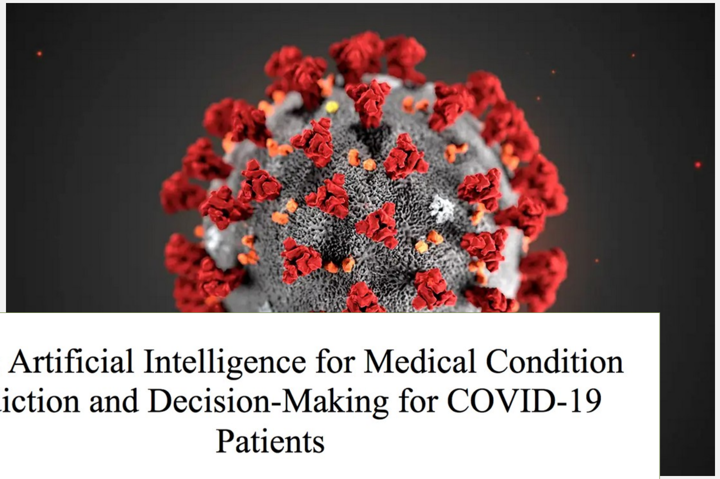
Instagram

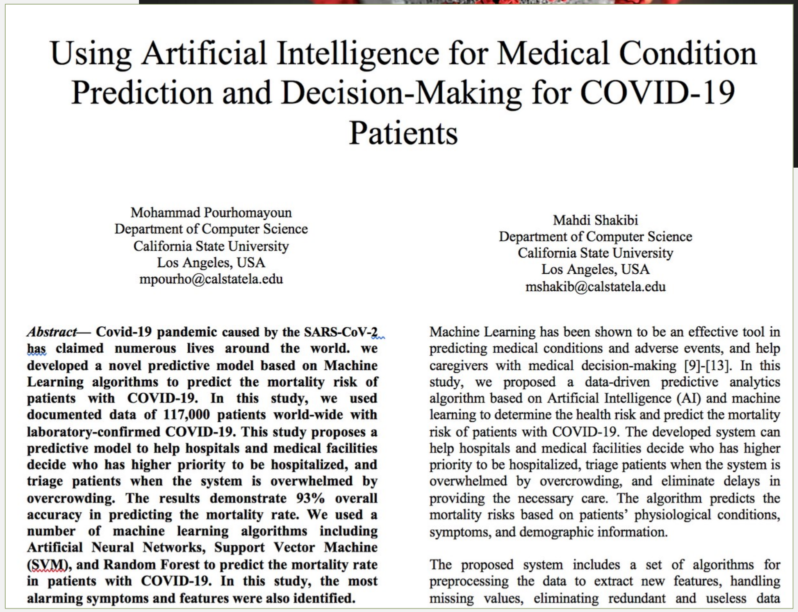
Social Media

Project Overview

- **<u>Artificial Intelligence and Data Science to Address COVID-19</u>**
- Developed a predictive model based on AI and ML to ***determine the health risk and predict the mortality risk of patients with COVID-19***. This model helps hospitals and medical facilities decide who needs to get attention first, who has higher priority to be hospitalized when the system is overwhelmed, and eliminate delays in providing the necessary care.







Using Artificial Intelligence for Medical Condition Prediction and Decision-Making for COVID-19 Patients

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Abstract— **Covid-19 pandemic caused by the SARS-CoV-2 has claimed numerous lives around the world. We developed a novel predictive model based on Machine Learning algorithms to predict the mortality risk of patients with COVID-19. In this study, we used documented data of 117,000 patients world-wide with laboratory-confirmed COVID-19. This study proposes a predictive model to help hospitals and medical facilities decide who has higher priority to be hospitalized, and triage patients when the system is overwhelmed by overcrowding. The results demonstrate 93% overall accuracy in predicting the mortality rate. We used a number of machine learning algorithms including Artificial Neural Networks, Support Vector Machine (SVM), and Random Forest to predict the mortality rate in patients with COVID-19. In this study, the most alarming symptoms and features were also identified.**

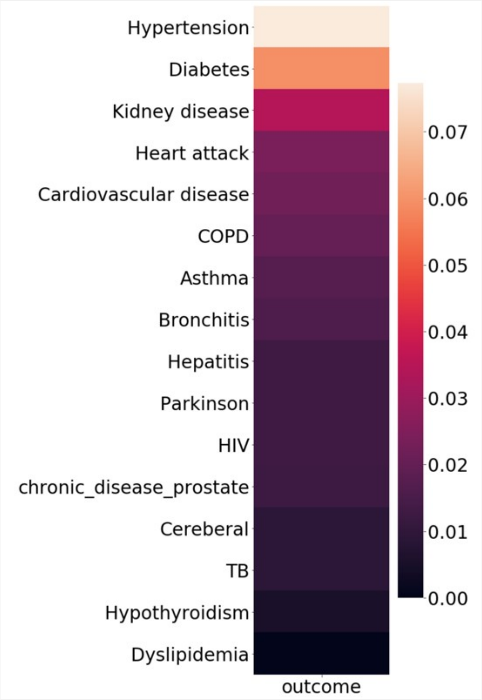
Machine Learning has been shown to be an effective tool in predicting medical conditions and adverse events, and help caregivers with medical decision-making [9]-[13]. In this study, we proposed a data-driven predictive analytics algorithm based on Artificial Intelligence (AI) and machine learning to determine the health risk and predict the mortality risk of patients with COVID-19. The developed system can help hospitals and medical facilities decide who has higher priority to be hospitalized, triage patients when the system is overwhelmed by overcrowding, and eliminate delays in providing the necessary care. The algorithm predicts the mortality risks based on patients' physiological conditions, symptoms, and demographic information.

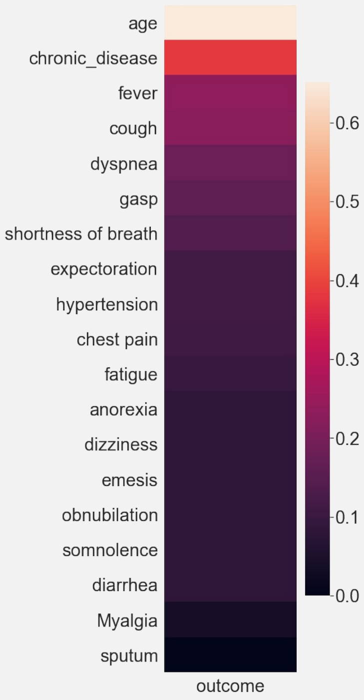
The proposed system includes a set of algorithms for preprocessing the data to extract new features, handling missing values, eliminating redundant and useless data

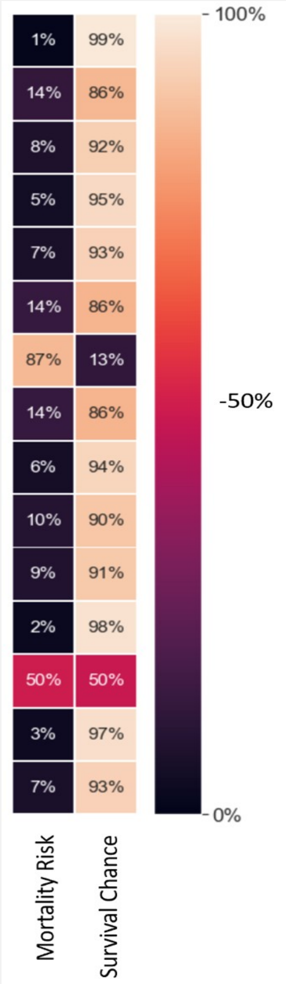
Ref:
www.medrxiv.org/content/10.1101/2020.03.30.20047308v1

Activities/Results

- **<u>Artificial Intelligence and Data Science to Address COVID-19</u>**
- Results: Predicting the Patients Mortality Rate with %90 accuracy using Deep Artificial Neural Networks!







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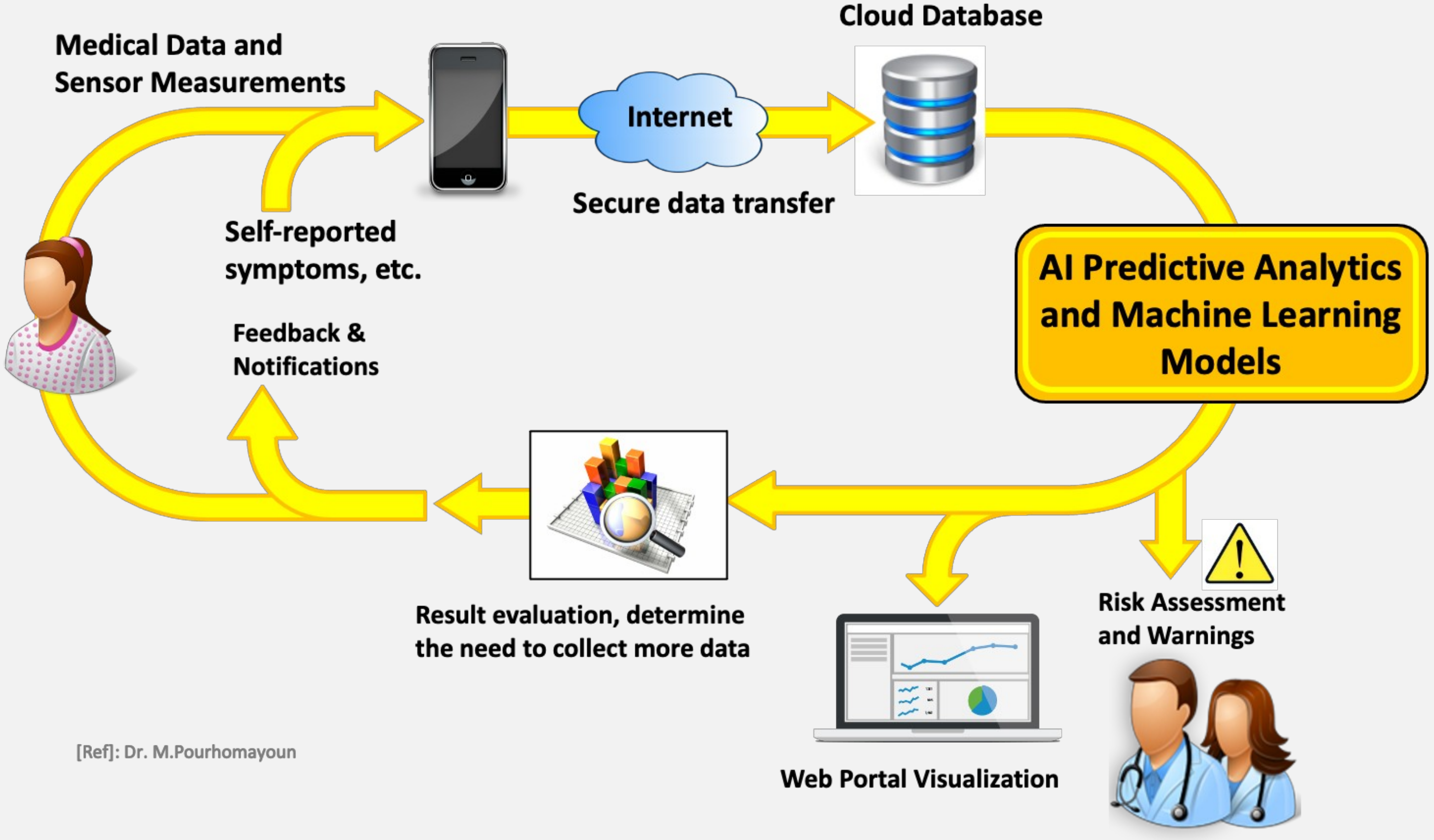
www.medrxiv.org/content/10.1101/2020.03.30.20047308v1

Project Overview

- **Artificial Intelligence and Machine Learning for Chronic Disease Monitoring and Management and Predicting Medical Conditions.**

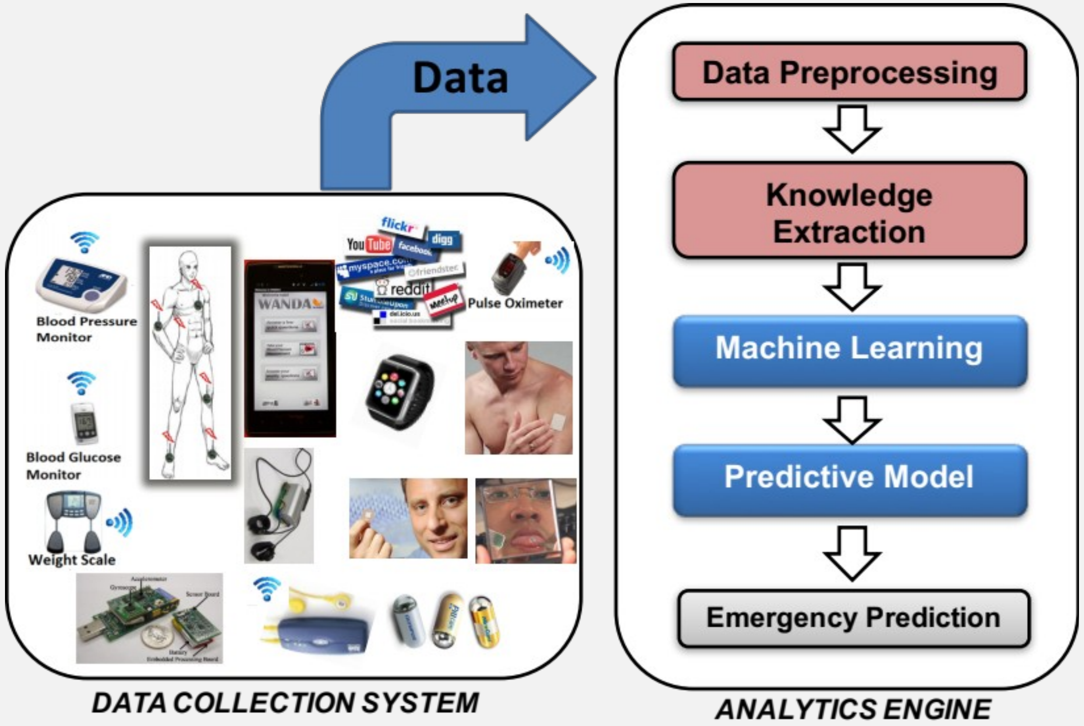


[Ref]: Dr. M.Pourhomayoun

Ref: [6][12][14][18]-[65]
www.calstatela.edu/research/data-science

Project Overview

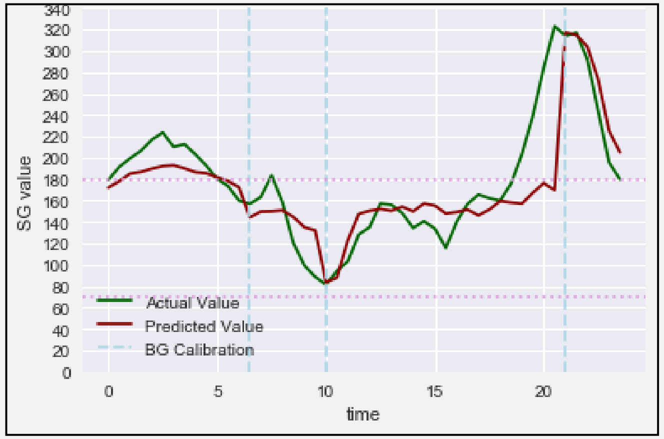
- **Case Studies in:** Cardiovascular Disease, Diabetes, Cancer, AIDS, Heart Failure, Osteoporosis, Kidney failure, Liver disease, General Hospital Readmission.
- More information:
  Ref: [6][12][14][18]-[65]
  www.calstatela.edu/research/data-science



Artificial Intelligence: From Science Fiction to Real Life with Case Studies in Healthcare

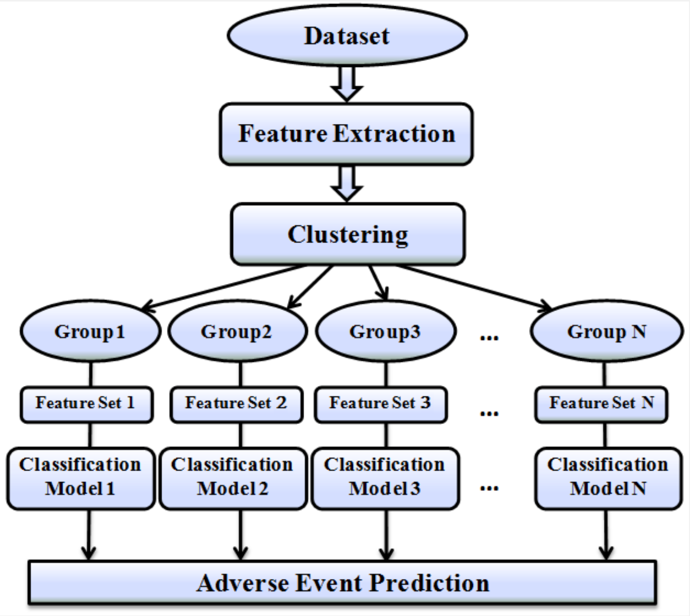
Activities/Results

- **A Case Study in Diabetes:** Predicting Continuous Glucose Levels in Patients with Diabetes Based on Physiological Data and Physical Activity Data.



- **A Case Study in Cardiovascular Disease:** Using Machine Learning to Predict Medical Adverse Events in Patients with Cardiovascular Disease or Heart Failure.
- More information:

Dataset	TPR for FPR=30%
Cluster 1	100%
Cluster 2	95%
Cluster 3	91%
Cluster 4	84%
Cluster 5	89%
Cluster 6	93%
Cluster 7	85%
Cluster 8	83%

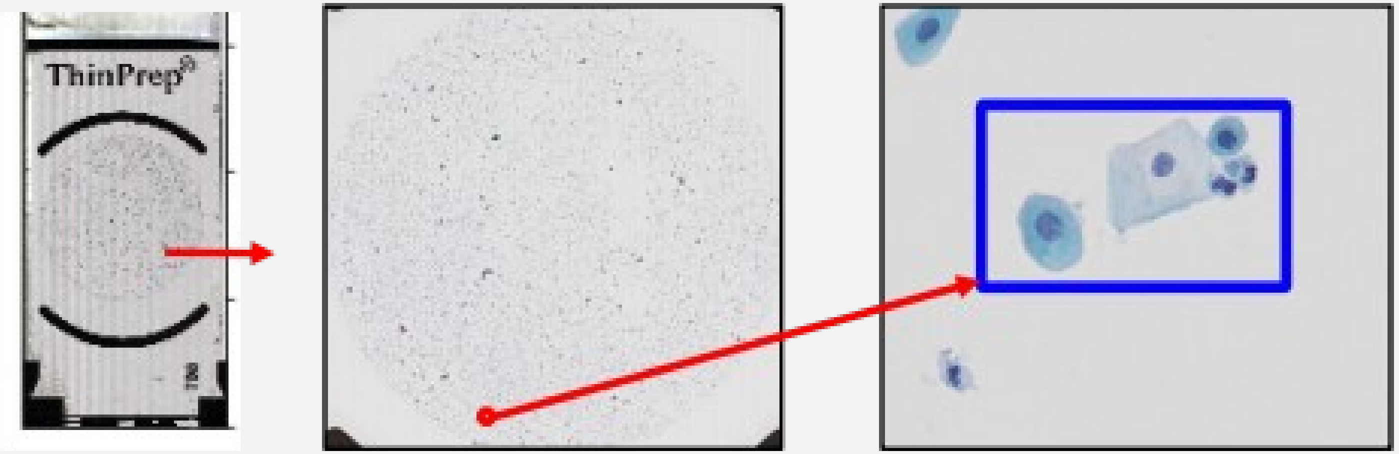


Ref: [14][21][35]-[40]
www.calstatela.edu/research/data-science

Project Overview

- **Artificial Intelligence and Machine Learning in Cytopathology for Early Detection of Cancer**
- A case study: Cervical Cancer
- Although the Pap test is an effective method for early detection of cervical cancer, it is very expensive and time-consuming because the Pap test method requires visual examination of thousands of cells by a trained pathologist.

Ref: [1][8][20]
www.calstatela.edu/research/data-science



Each picture is 300,000 x 100,000 px ~ 30GB!

Activities/Results

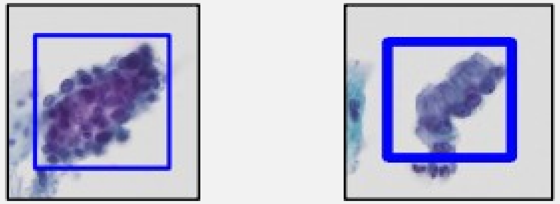


Figure2: Abnormal cell (in this case a malignant cancerous cell) (left), versus normal cell (right).

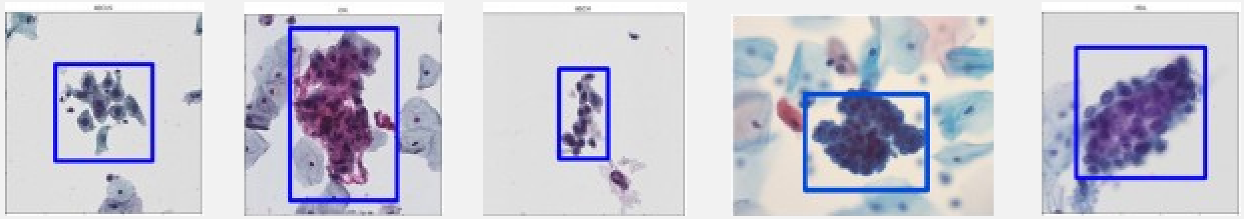


Figure3: Different types of abnormalities: from left to right: Atypical squamous cells of undetermined significance (ASCUS), Low–grade squamous intraepithelial lesion (LSIL) , Endometrial, Atypical squamous cells HSIL(ASCH).

Table 5 Binary classification results

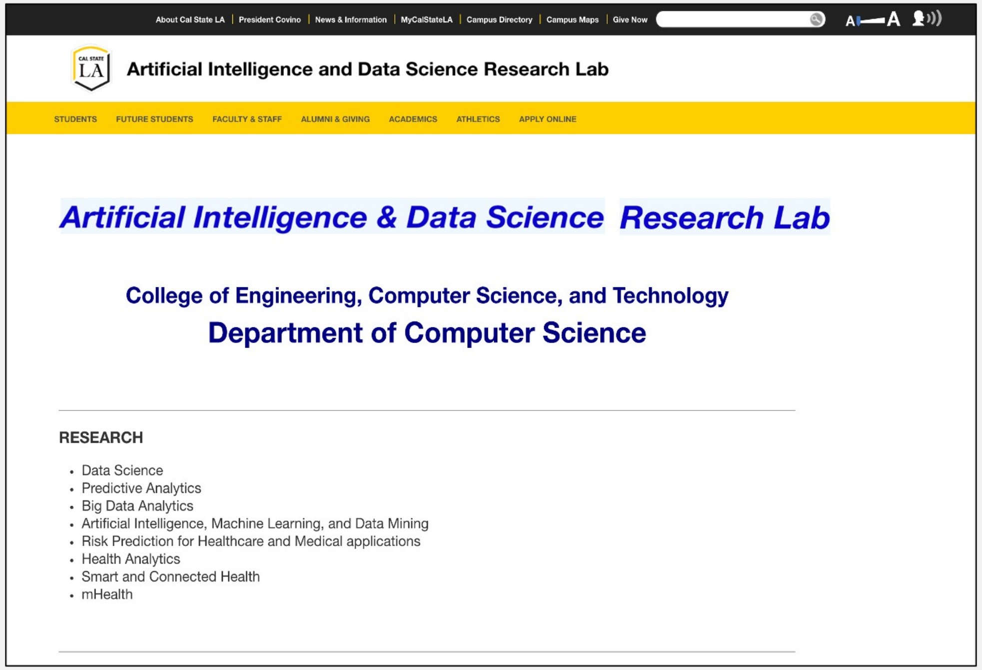
Method	Cross validation	Accuracy	Sensitivity	Specificity
Ensemble learning	5-fold	90.37%	96.33%	83.59%
Deep learning	5-fold	91.63%	95.47%	87.43%

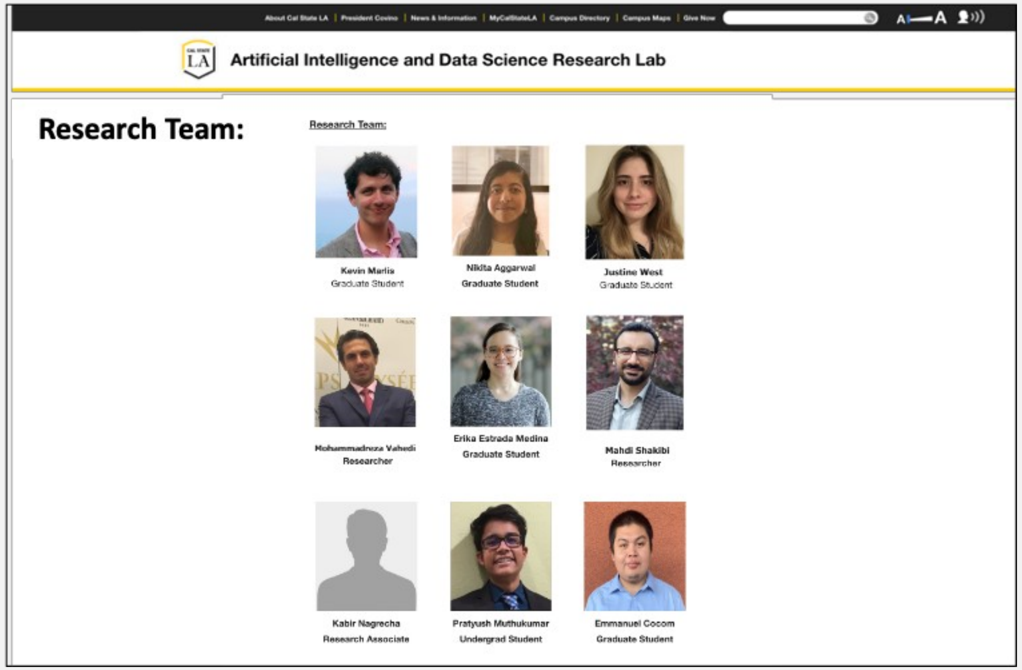
Important Feature: The algorithm receives the the entire image (30GB) as an input, and provide the results right away.

Ref: [1][8][20]
www.calstatela.edu/research/data-science

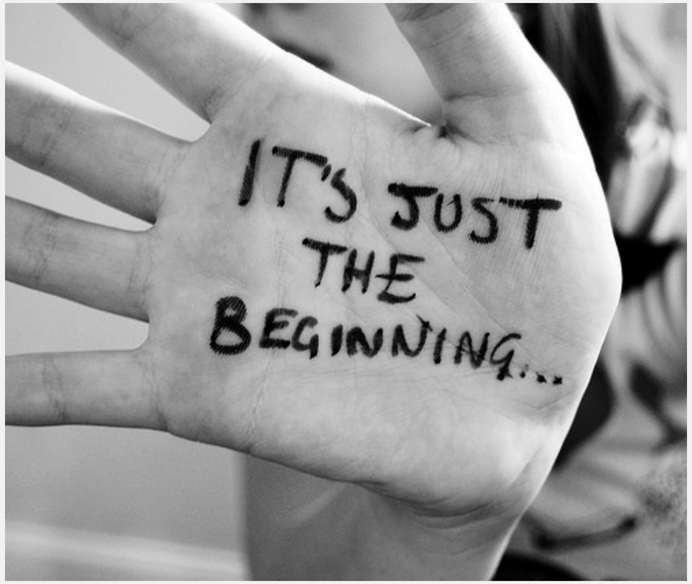
Next Steps/Long-Term Plans

Visit our Artificial Intelligence & Data Science Research Lab at:
www.calstatela.edu/research/data-science





Next Steps/Long-Term Plans



Adventures in Deep Learning: Learning to Predict Depth in Panoramic Video and Count Trees in Remote Sensing Data

Jonathan Ventura – Cal Poly SLO

Collaborators: G. Andrew Fricker, Cal Poly SLO

Jonathan Ventura, Assistant Professor

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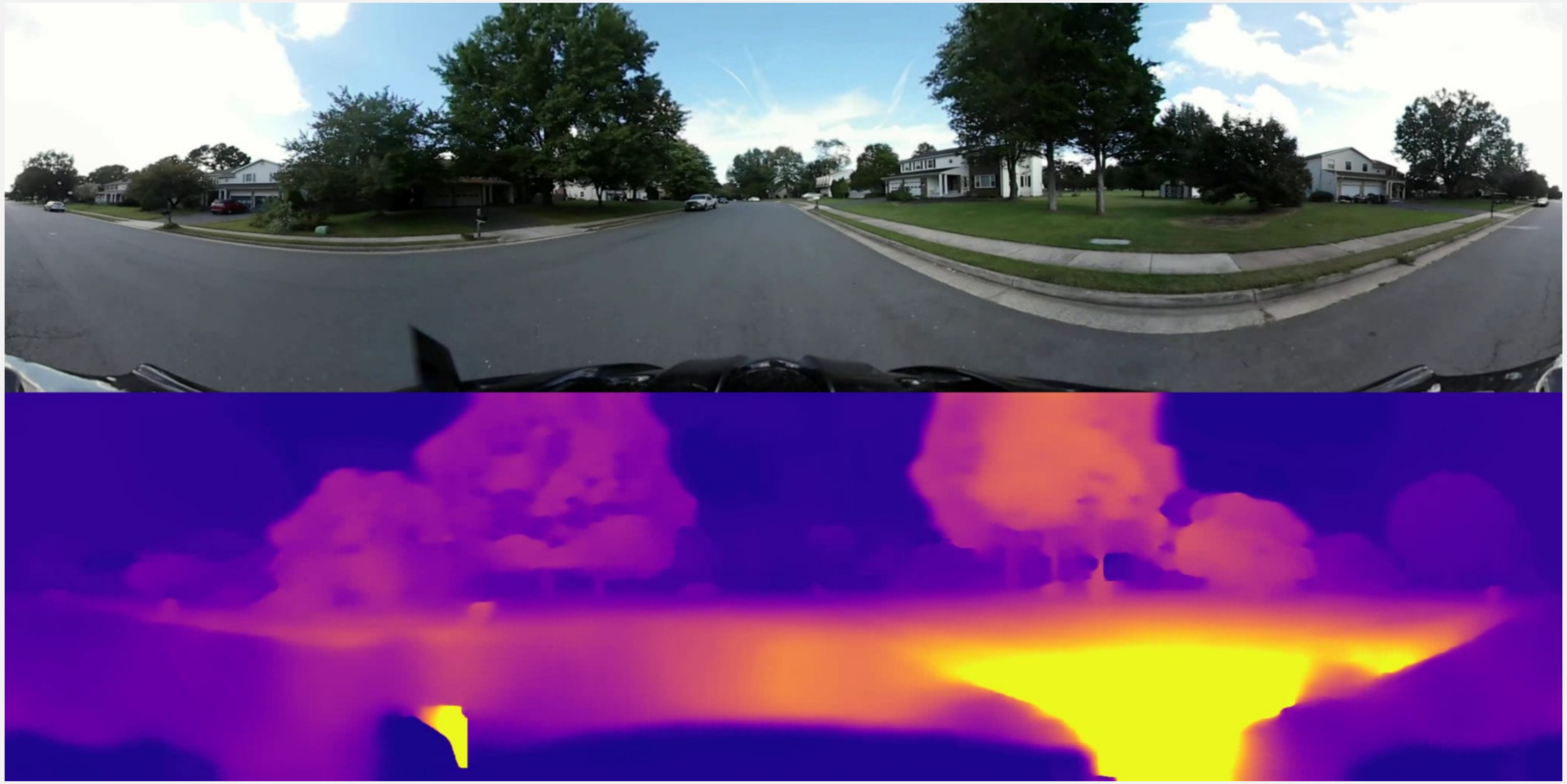
CAL POLY

Adventures in Deep Learning: Learning to Predict Depth in Panoramic Video and Count Trees in Remote Sensing Data

Project Overview

- Idea:
- Learn to predict a depth map from an input panorama
- Applications:
- Cheaper and lighter replacement for LIDAR
- 3D scene reconstruction for virtual reality



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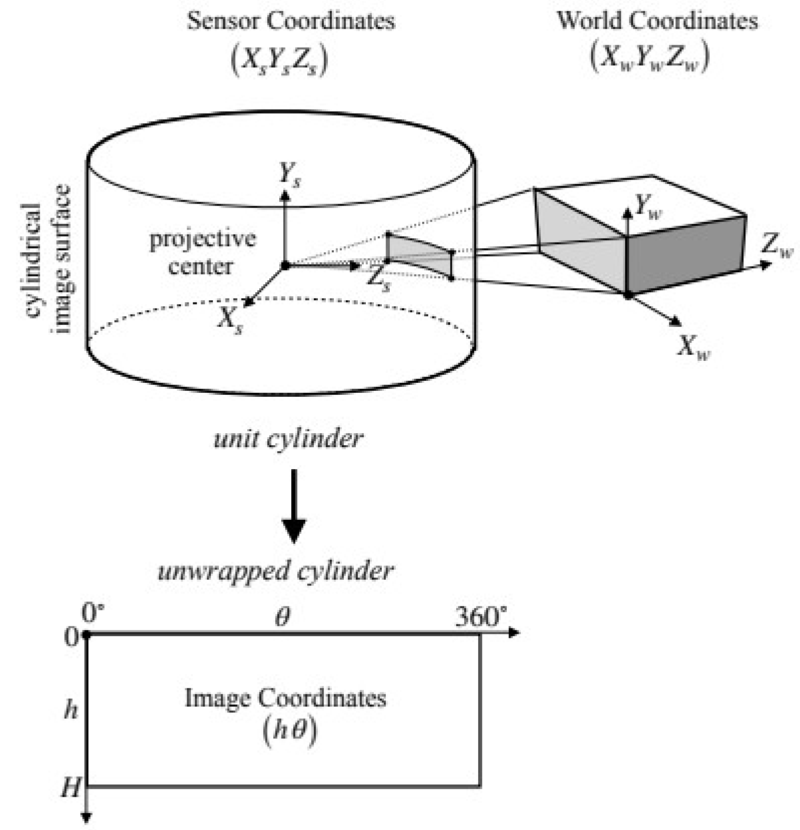
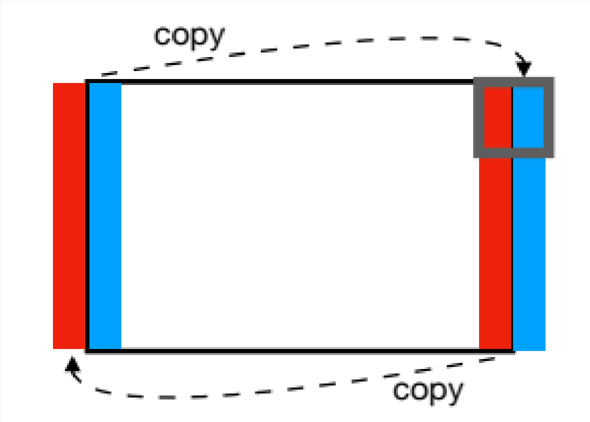
A. Sharma and J. Ventura. Unsupervised learning of depth and ego-motion from cylindrical panoramic video. IEEE AIVR 2019.
A. Sharma, R. Nett, and J. Ventura. Unsupervised learning of depth and ego-motion from cylindrical panoramic video with applications for virtual reality, IJSC 2020.

Methods

Adventures in Deep Learning: Learning to Predict Depth in Panoramic Video and Count Trees in Remote Sensing Data

- Unsupervised learning approach: Learns directly from panoramic video, without depth supervision
- Convolutional Neural Networks predict depth map and relative pose between frames
- Uses cylindrical projection and wrap padding to support panoramic input





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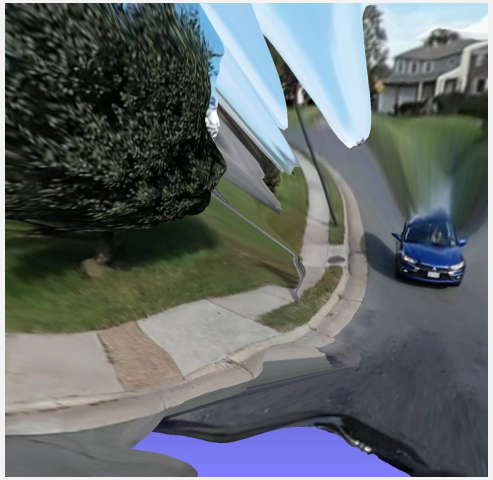
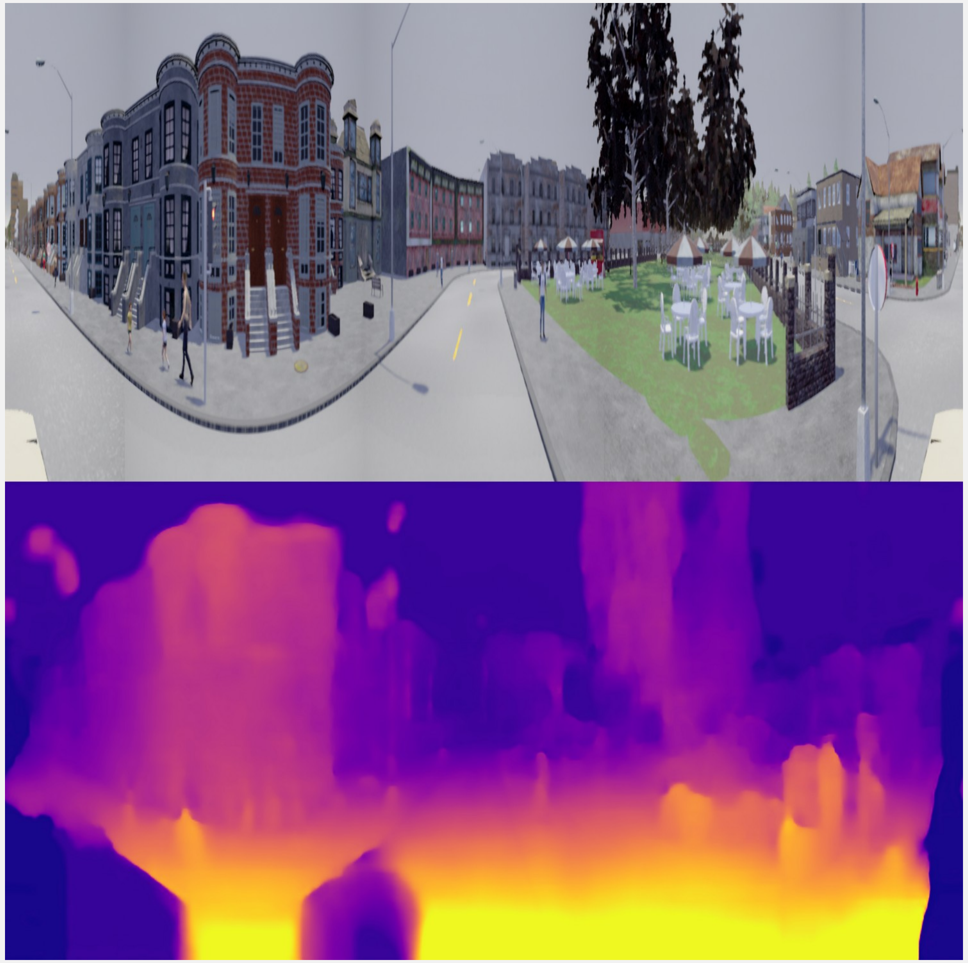
Adventures in Deep Learning:
Learning to Predict Depth in Panoramic Video and Count Trees in Remote Sensing Data

Results

- Tested on real and synthetic data
- Can render new viewpoints and stereo panoramas using our predicted depth maps





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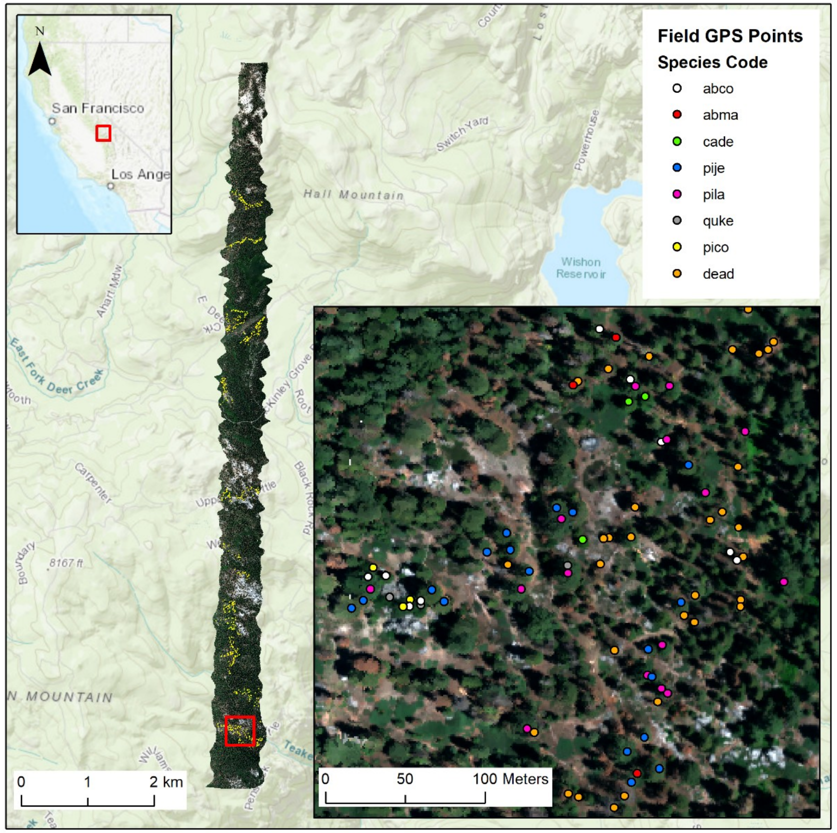
Adventures in Deep Learning: Learning to Predict Depth in Panoramic Video and Count Trees in Remote Sensing Data

Project Overview

- <u>Idea:</u>
- Learn to predict tree species from hyperspectral aerial images
- <u>Applications:</u>
- Automatic forest cataloging
- Support data-driven research on biodiversity and climate change



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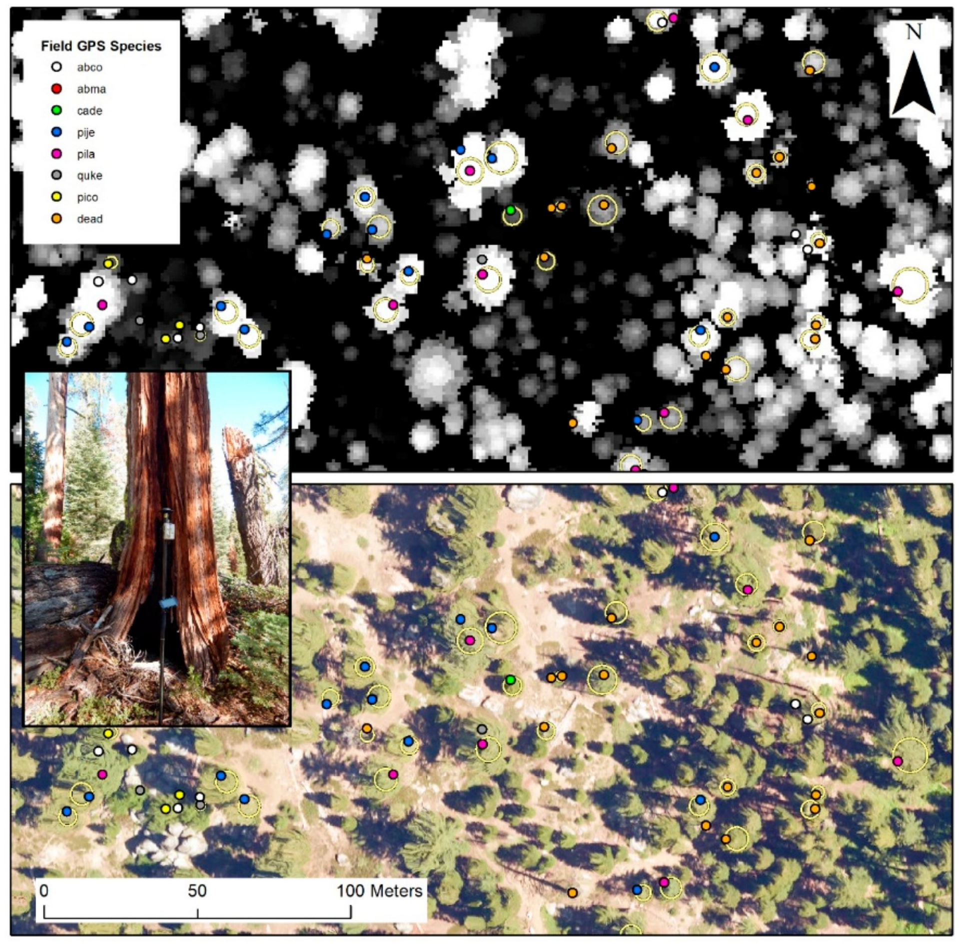
G. A. Fricker, J. D. Ventura, J. A. Wolf, M. P. North, F. W. Davis, J. Franklin. A Convolutional Neural Network Classifier Identifies Tree Species in Mixed-Conifer Forest from Hyperspectral Imagery. *Remote Sens.* **2019**, *11*(19), 2326.

Adventures in Deep Learning: Learning to Predict Depth in Panoramic Video and Count Trees in Remote Sensing Data

Methods

- Trees identified manually and tagged with high-accuracy GPS along several transects
- Data collection at a NEON site in the Sierra Nevada forest
- 713 trees labeled
  - Eight species + dead tree label
  - Severe class imbalance (smallest class "Black oak" has 18 examples)



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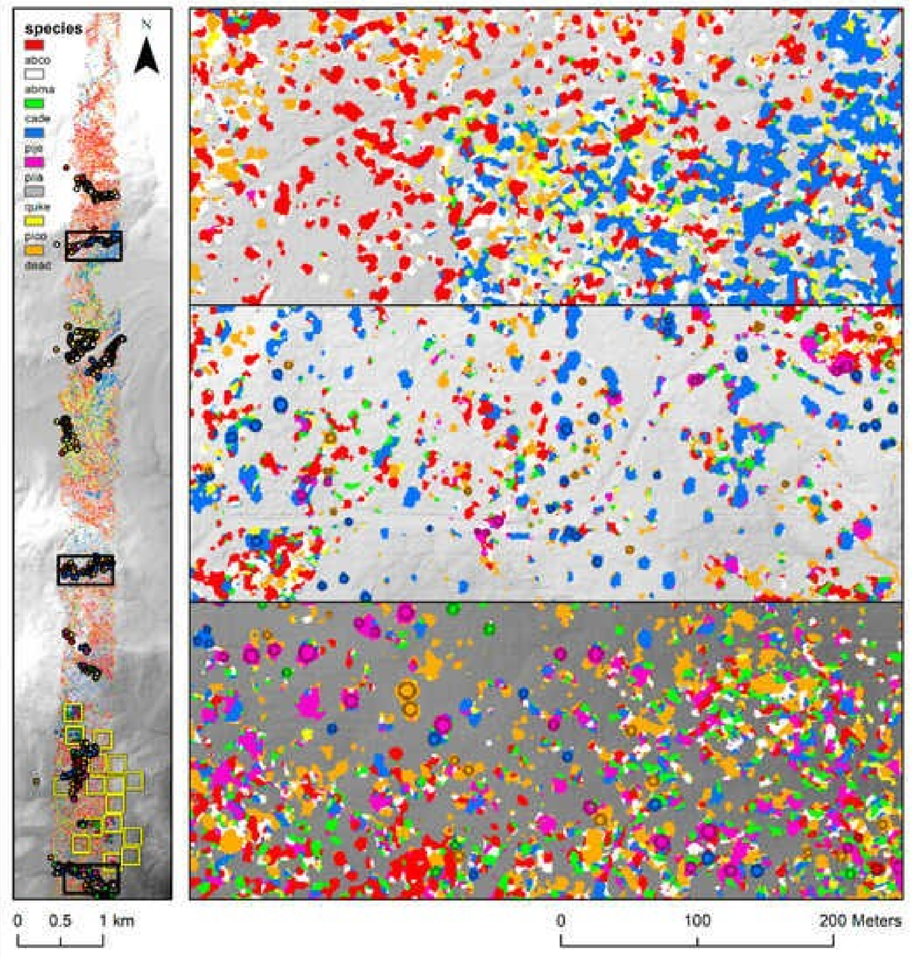
Adventures in Deep Learning:
Learning to Predict Depth in Panoramic Video and Count Trees in Remote Sensing Data

Results

- Hyperspectral data: 426 bands per pixel
  - Applied PCA to reduce to 32 dimensions per pixel
- Fully convolutional neural network design

Data Type	F-Score
RGB	0.64
Hyperspectral	**0.87**

- Difficult to distinguish White Fir and Red Fir
- Some confusion with dead trees



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Next Steps/Long-Term Plans

- Deep Learning for 3D Vision:
  - Short-term: Alternate loss functions and regularizes to reduce depth map artifacts
  - Long-term: New approaches for panoramic scene capture for viewing in a VR headset

- Tree Counting in Remote Sensing Data:
  - Short-term: Improvements in classification accuracy from other data sources such as LIDAR
  - Long-term: Analyzing the California urban forest using 5M-tree dataset from CalFire

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Toward the Next-Generation Neural-Machine Interfaces for Neurorehabilitation

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Toward the Next-Generation Neural-Machine Interfaces for Neurorehabilitation

Project Overview

- **Research Motivation**

Image from: http://www.sfchronicle.com/business/article/Teen-helps-test-design-3-D-printed-prosthetic-6871543.php#photo-9501708

- Over 1.6 million amputees in the US, over 32 million worldwide
- Most commercial prosthetic arms require the user to switch the control mode manually or using body motion, which is cumbersome.

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Project Overview

- **Research Motivation**

Can we control a prosthetic limb as if it is the user's own limb?

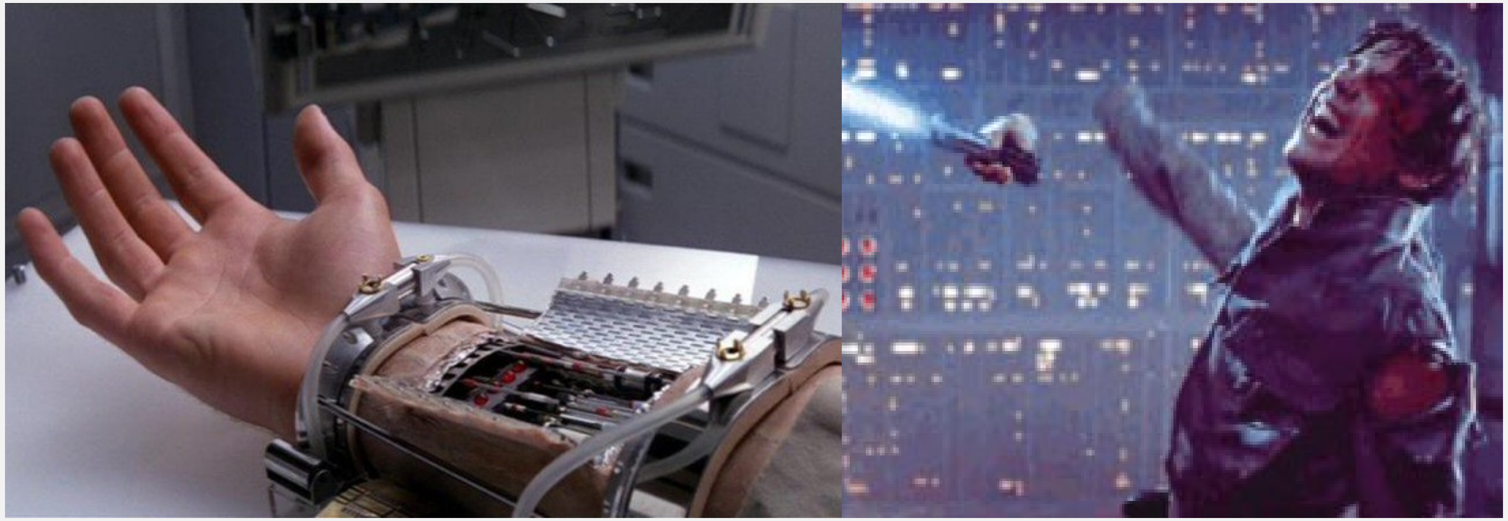


Image from: http://www.runleiarun.com/choppedoffhands/sw5.html

Luke Skywalker's prosthetic arm in Star Wars: The Empire Strikes Back (1980)

Toward the Next-Generation Neural-Machine Interfaces for Neurorehabilitation

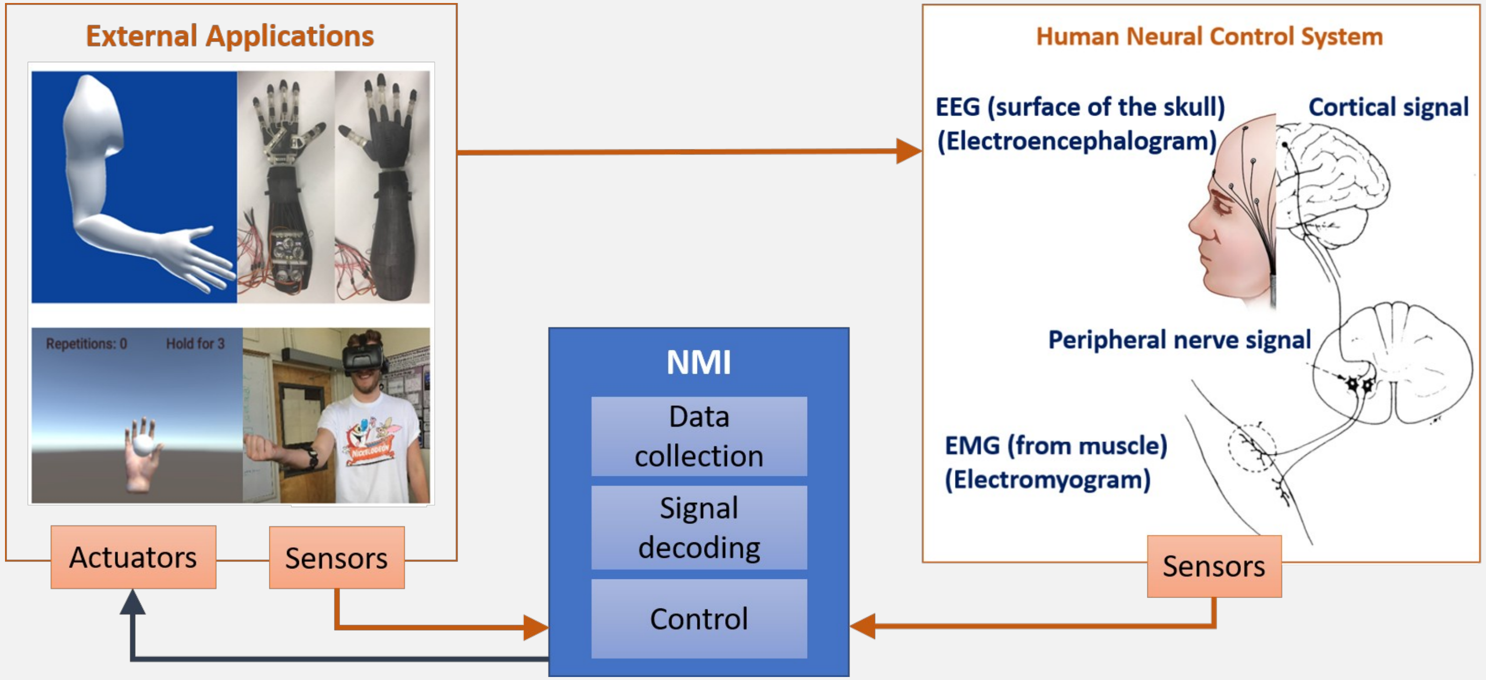
Project Overview

NSF Disability and Rehabilitation Engineering (DARE)

- ***Our goal:*** To develop the **next-generation neural-machine interfaces (NMIs)** that allow intuitive and natural control of prosthetic and rehabilitation applications (e.g. prosthetic arms that perform like natural arms)

➢ NMI is a communication pathway between human neural control system and machine.

➢ NMI is a biomedical cyber-physical system (CPS).



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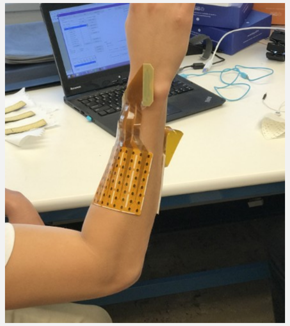
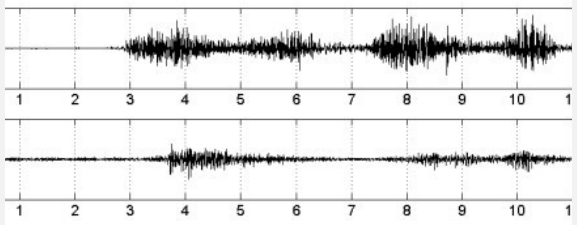
Activities

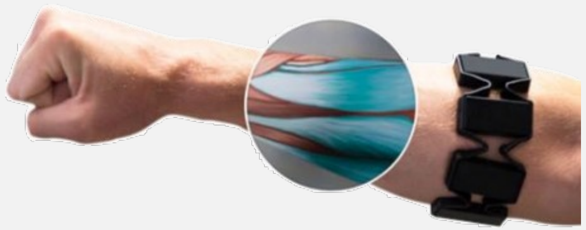
- EMG (Electromyogram) signals are effective bioelectric signals for expressing movement intent



➢ High-density EMG system (EMG-USB2, OT Bioelettronica)

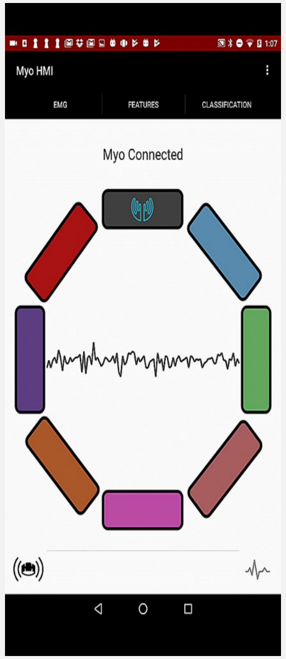


➢ Example EMG signals



➢ 8-sensor EMG array (Myo armband, Thalmic Labs)

➢ Single-channel EMG sensor (Delsys)



➢ ***MyoHMI*** app - a low-cost, flexible NMI for EMG- controlled applications (*IEEE SMC 2016, ASEE PSW 2018, 2019*)

➢ Developed by ***David*** (EECS'Sp19), ***Louie*** (EE/CompE'F19), ***Phan*** (EE/CompE'Sp20)), and ***seven community college student interns***

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Picture from: http://www.readcube.com/articles/10.1186/

SAN FRANCISCO STATE UNIVERSITY

Toward the Next-Generation Neural-Machine Interfaces for Neurorehabilitation

Activities

- **Challenges in recognizing user intent**
  - Limited signal sources for patients
  - Extracting meaningful neuromuscular information to achieve high functionality and robustness
  - Environmental uncertainty
- **Challenges in NMI implementation**
  - Real-time response
  - Portability
  - Usability

- **Innovations addressing these challenges**
  - Machine learning and pattern recognition-based signal decoding
  - High-density grid sensing technology
  - Sensor fault tolerance module
  - New hierarchical computing framework
  - New computing technologies (e.g. neuromorphic computing, edge computing)
  - New neurorehabilitation applications through multidisciplinary collaborations

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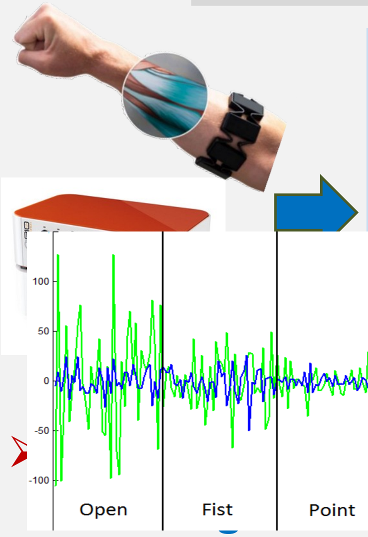
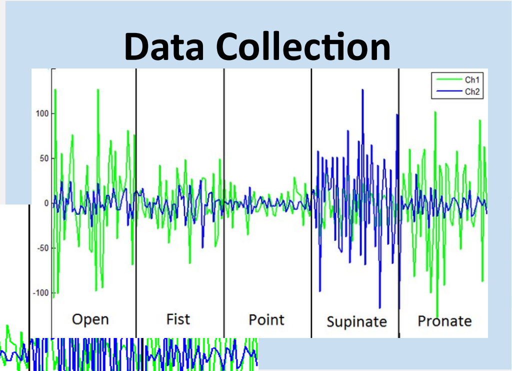
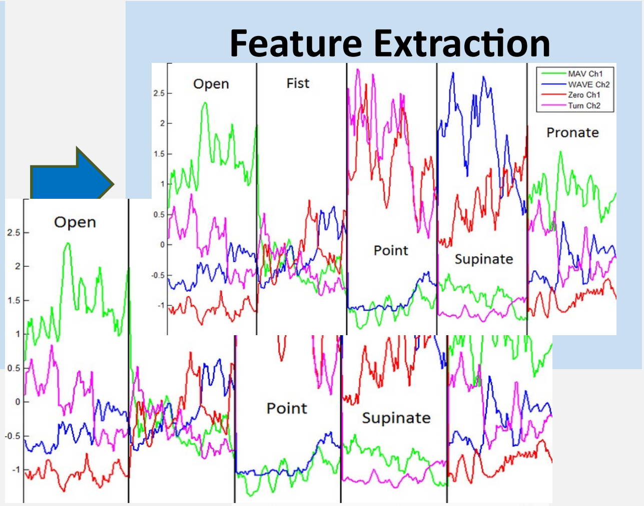
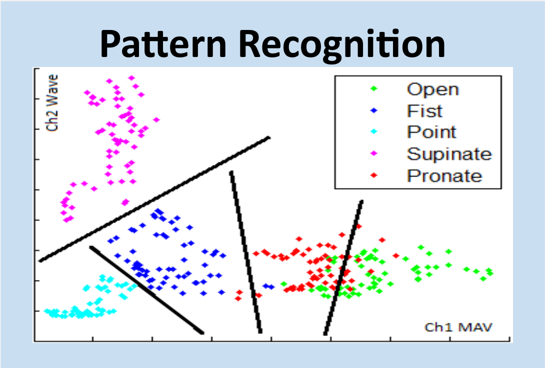
Toward the Next-Generation Neural-Machine Interfaces for Neurorehabilitation

Activities & Results

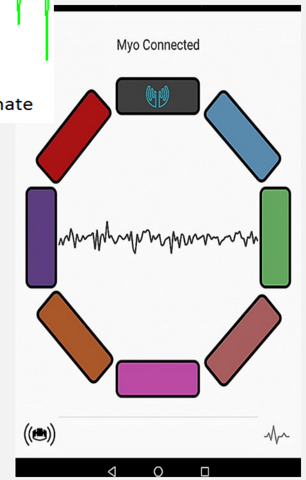


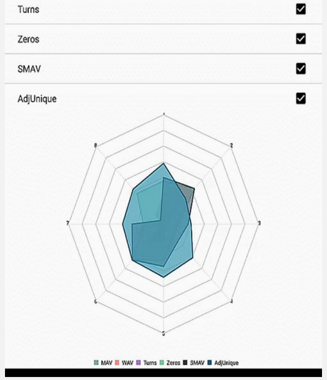


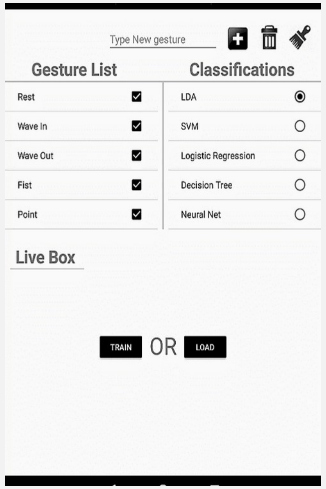


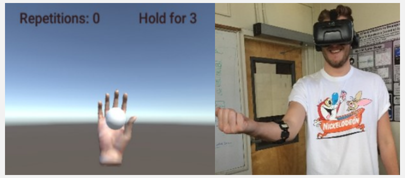


- EMG-based NMI for user intent recognition









- ***MyoHMI*** app - a low-cost, flexible NMI for EMG-controlled applications (*IEEE SMC 2016, ASEE PSW 2018, 2019*)

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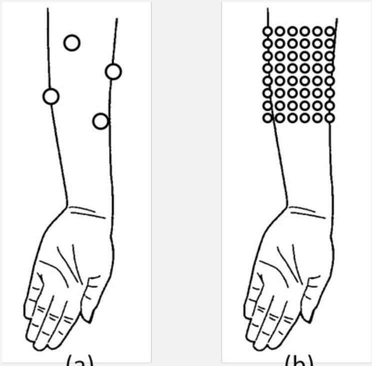
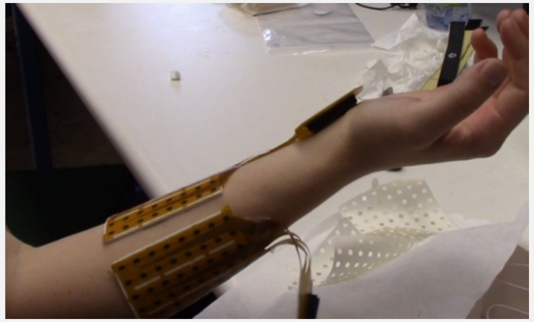
Toward the Next-Generation Neural-Machine Interfaces for Neurorehabilitation

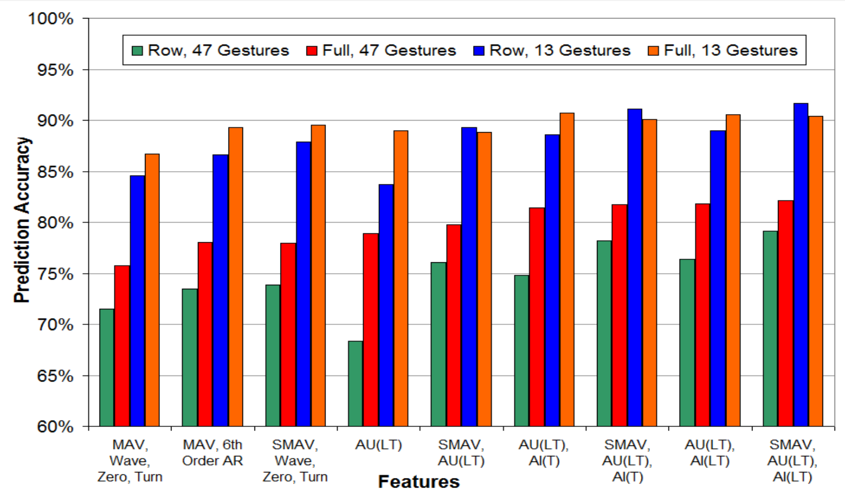
Activities & Results

- **High-Density (HD) EMG-based Pattern Recognition**
  - Utilize richer neuromuscular information obtained from HD EMG arrays
  - Develop new feature set from spatial-temporal domain
  - Tested on datasets discriminating 47 hand and wrist gestures
  - Boost accuracies while maintaining computational efficiency

IEEE EMBC 2017, 2018 (***Donovan*** (EECS' F17), ***Phan*** (CompE/EE' Sp20))


(a) (b)





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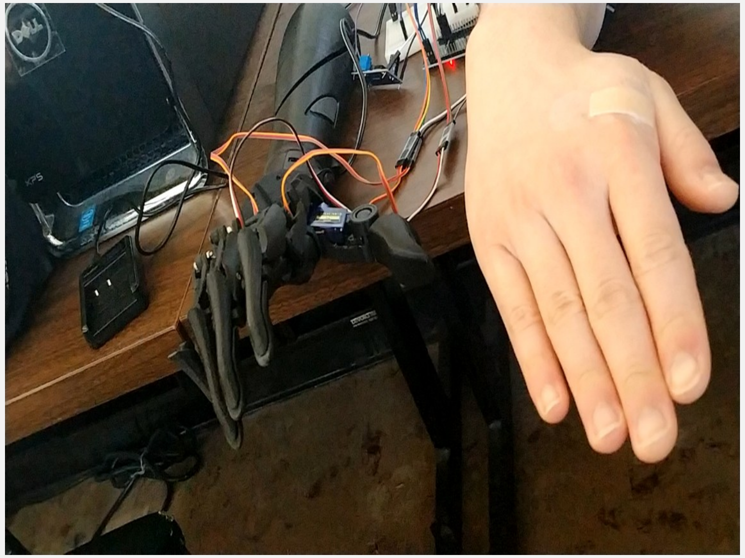
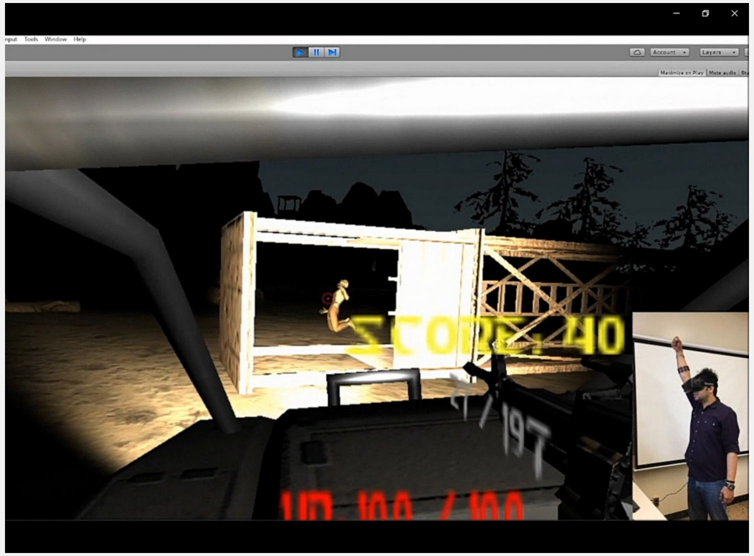
Toward the Next-Generation Neural-Machine Interfaces for Neurorehabilitation

Activities & Results

- **Myoelectric Controlled Applications**



- ***MyoHMI*** controlling 3D printed prosthetic hand
- Developed by ***Phan*** (CompE/EE'Sp20)
- 1st place award at the CSU Research Competition, April 2020



- ***MyoHMI*** controlling a first-person-shooter (FPS) VR game
- Developed by ***Bholla*** (EECS'Sp18), ***Thomas*** (community college intern)

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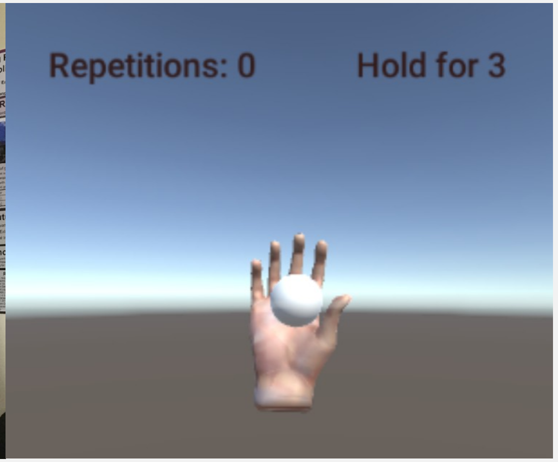
Activities & Results

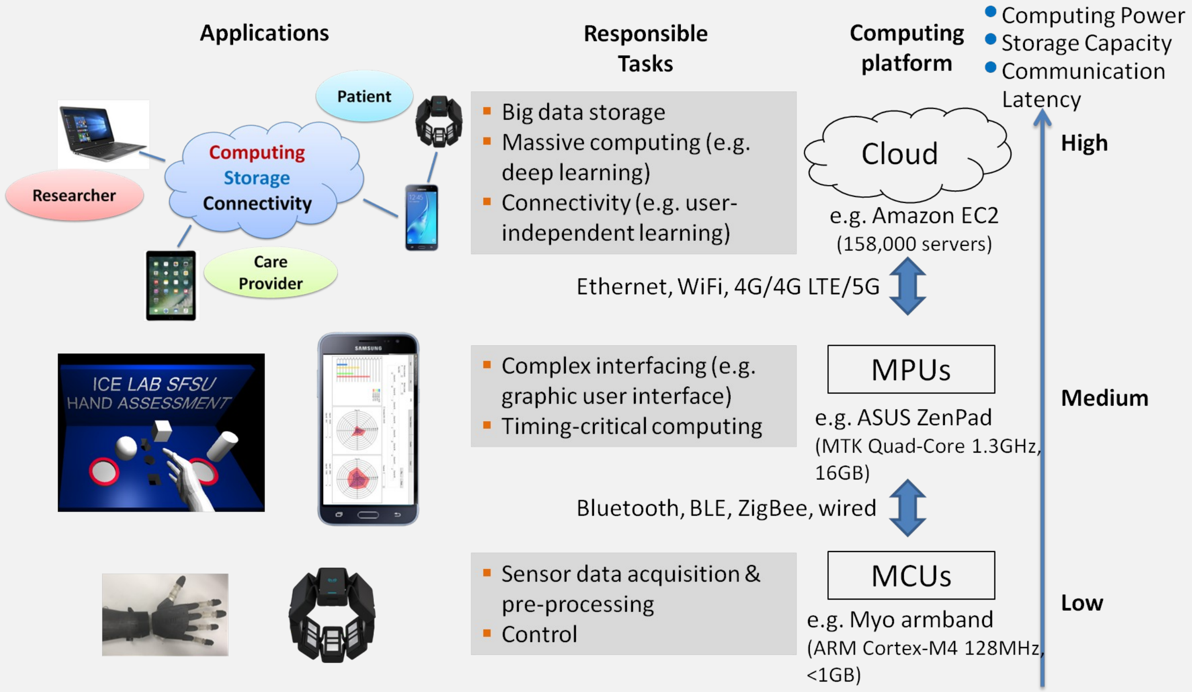
- **Myoelectric Controlled Applications**
  - ***VRehab***: A Low-Cost Mobile VR system for Post-Stroke Upper Limb Rehabilitation (*IEEE GHTC 2018*)

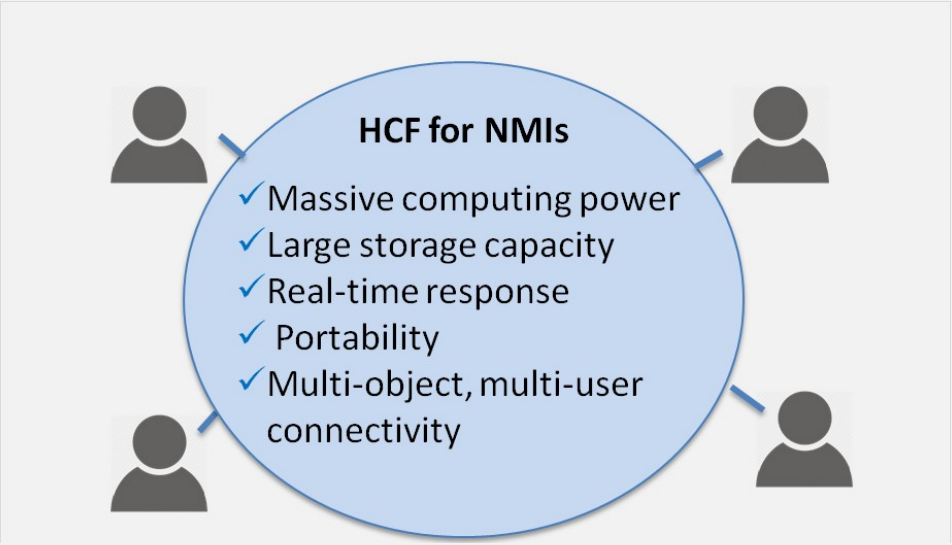


- Collaborators: ***Dr. Hughes*** (Kinesiology, Health Equity Institute, SFSU)
- Developed by ***Zirbel*** (CompE' Sp19)
- 1st place award at the CSU Research Competition, May 2018

Next Steps/Long-Term Plans

- **New hierarchical computing framework (HCF) and new computing platforms (e.g. edge computing, neuromorphic computing) for next-gen NMIs** (collaborator: ***Dr. Hao Jiang***, EE, SFSU)





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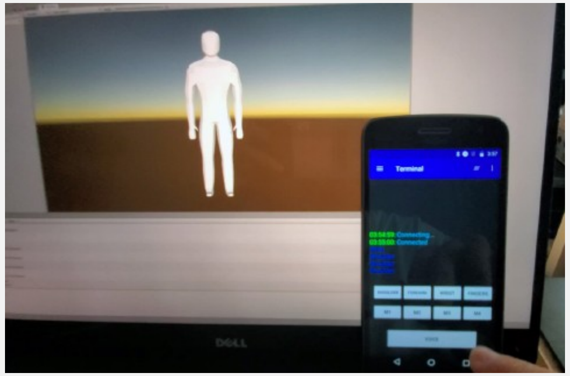
Next Steps/Long-Term Plans

- Development of HD EMG-based sensor fault tolerance modules (*Reynolds* (EE student), *Shazar* (CompE student)) and machine learning algorithms for next-gen NMIs
- Development of new myoelectric-controlled neurorehabilitation applications through multidisciplinary collaborations



- **In-Home Robotic Therapy System**
- Collaborators: ***Dr. David Quintero*** (ME, SFSU) and ***Dr. Charmayne Hughes*** (Kinesiology, Health Equity Institute, SFSU)

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Acknowledgement

- **Student Researchers and Alumni:**

Aashin Shazar (CompE student)
Donald Reynolds (EE student)
Bao Tran (EECS student)
Myles Pedronan (EECS student)
Dung Nguyen (EECS student)
Justin Phan (EE/CompE Sp20)
Alisa Its (ME Sp20)

Alex Louie (EE/CompE F19)
Chloe Zirbel (CompE Sp19)
Juan Angeles (CompE Sp19)
Sean Booth (CompE/ME Sp19)
Alex David (EECS Sp19)
Travis Mazzy (EE F18)
Kyle Goodridge (EE Sp18)

Ian Hanna (ME Sp18)
Ian Donovan (EECS F17)
Kartik Bholla (MS in EECS)
Sergey Dusheyko (EECS F17)
Kevin Valenzuela (CompE Sp16)
Alejandro Ortiz (CompE F16)
Gilbert Szeto (CompE F14)

- **Collaborators**

Dr. Charmayne Hughes, Kinesiology, Health Equity Institute, SFSU
Dr. David Quintero, Mechanical Engineering, SFSU
Dr. Hao Jiang, Electrical Engineering, SFSU

- *Dr. Kazunori Okada, Computer Science, SFSU*

NSF Disability and Rehabilitation Engineering (DARE)

csuperb California State University Program for Education and Research in Biotechnology

SFSU Ken Fong Translational Research Fund

SFSU Center for Computing in Life Sciences (CCLS)

Introduction to Big Data and AI for Data Analytics and Prediction

Jongwook Woo – CalStateLA

Jongwook Woo, Full Professor
Cal State LA, Department of Information Systems
jwoo5@calstatela.edu

Project Overview

- Issues of Large-Scale Data
  - 3 Vs, 4 Vs,…
    - Volume, Variety, Velocity
  - Too big, Growing too quickly
  - Non-/Semi-structured data
  - Traditional Systems can but … cannot handle them
    - Too expensive

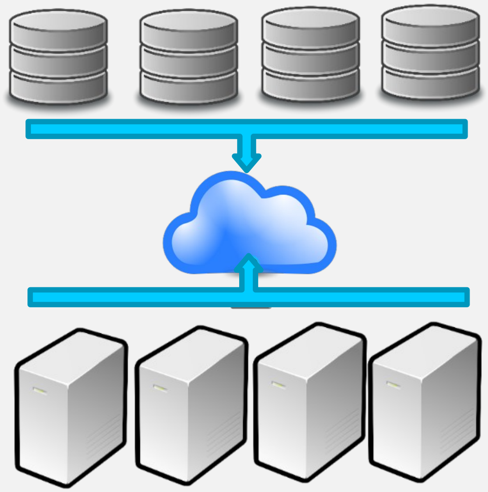
Project Overview: Big Data

- Need new systems
  - Non-expensive: Storage and Computing
- Non-expensive platform, which is distributed parallel computing systems and that can store a large-scale data and process it in parallel
  - Apache Hadoop and Spark since 2006
    - Non-expensive **Supercomputer**
  - Available to the public than the traditional super computers
    - Anyone can own **supercomputer** as open source
      - In your university labs, small companies, research centers

Project Overview: Big Data

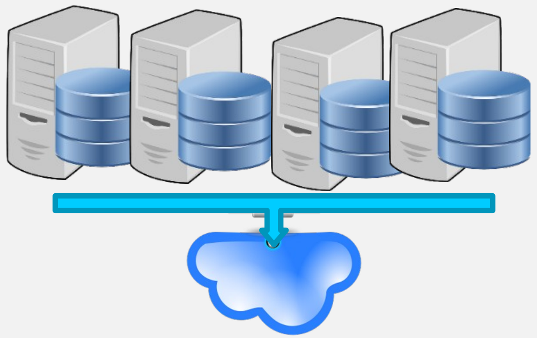
Traditional Supercomputer
(Parallel File Systems: Lustre, PVFS, GPFS)

Cluster for **Store**



Cluster for
Compute

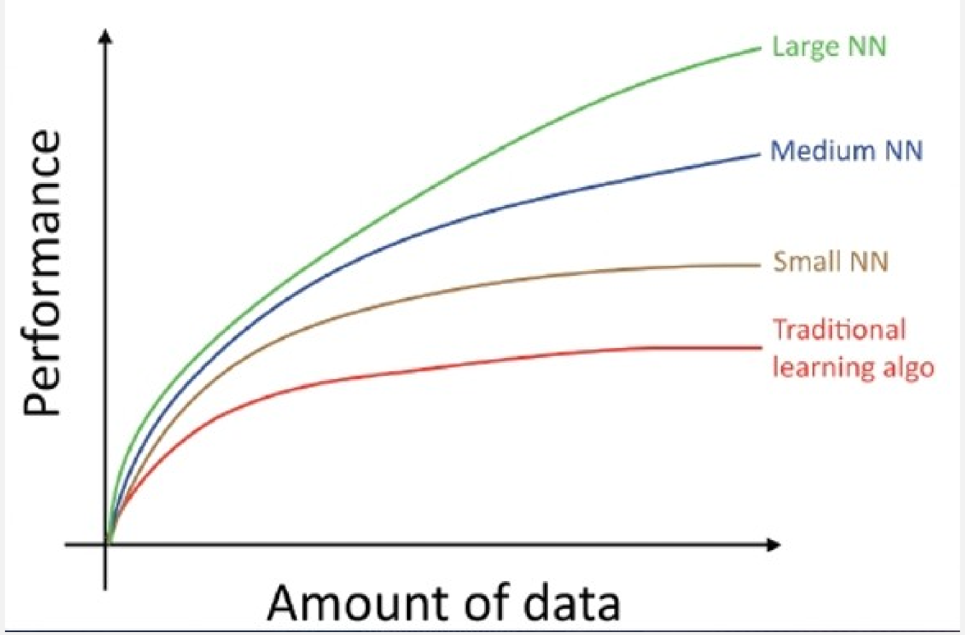
Big Data (Hadoop, Spark, Distributed Deep Learning)
Cluster for **Compute and Store**
(Distributed File Systems: HDFS, GFS)



However, Cloud Computing adopts this separated architecture:
with High-Speed N/W (> 10Gbps) and Object Storage

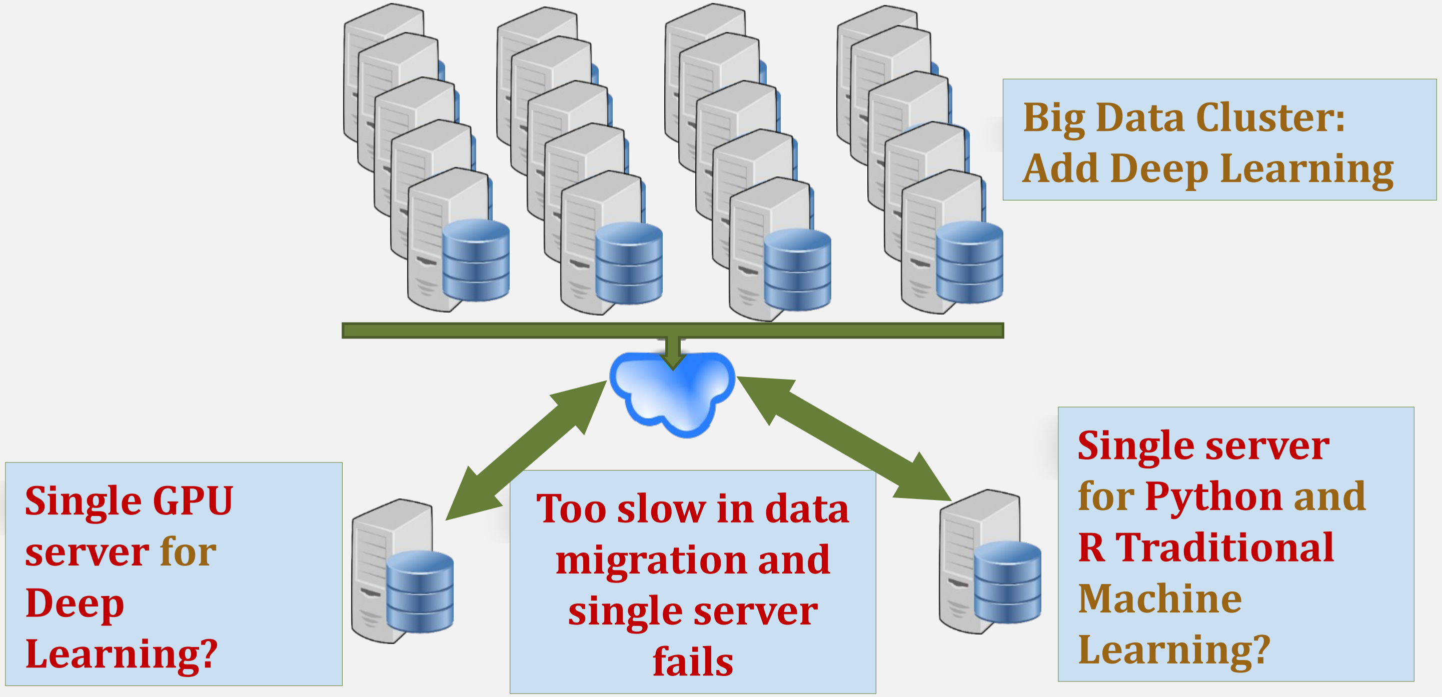
Project Overview: Deep Learning

- Deep Learning
  - Has been popular since Google Tensorflow, Nov 9 2015
  - Parallel Computing in a chip
  - Multiple Cores in GPU
    - Even with multiple GPUs and CPUs
- Deep Learning with Big Data
  - “Machine Learning Yearning” Andrew Ng 2016



Activities

- Deep Learning with Big Data
  - Integrate Deep Learning
    - to the Big Data cluster
  - Distributed Deep Learning

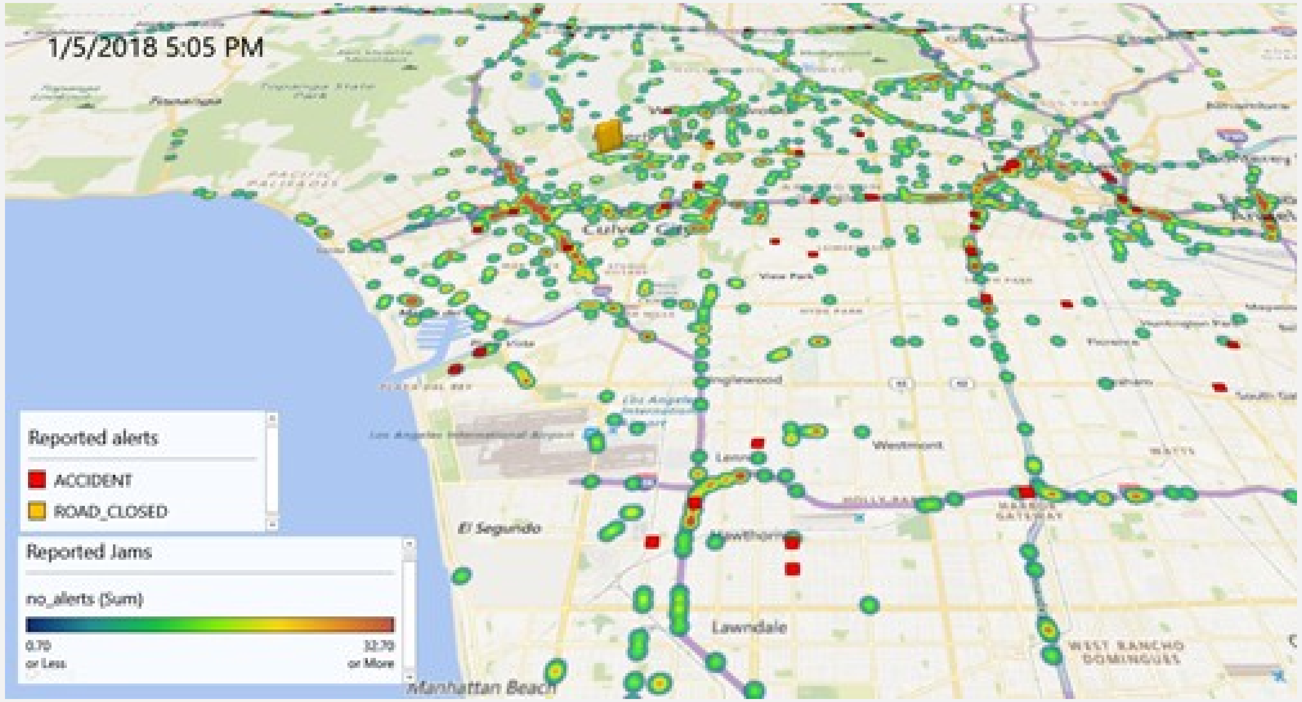


Activities

- Collaborators
  - City of Los Angeles, LA Zoo, LAFD, Data Science Federation of LA City
  - USC, Penn State Univ
  - Databricks, Elasticsearch, Cloudera, Tableau, Neo4j
- Research and Teaching Fund
  - Amazon AWS, Oracle Cloud, Google Cloud Platform, IBM Cloud
  - Warner Bros, Softzen, Wider planet

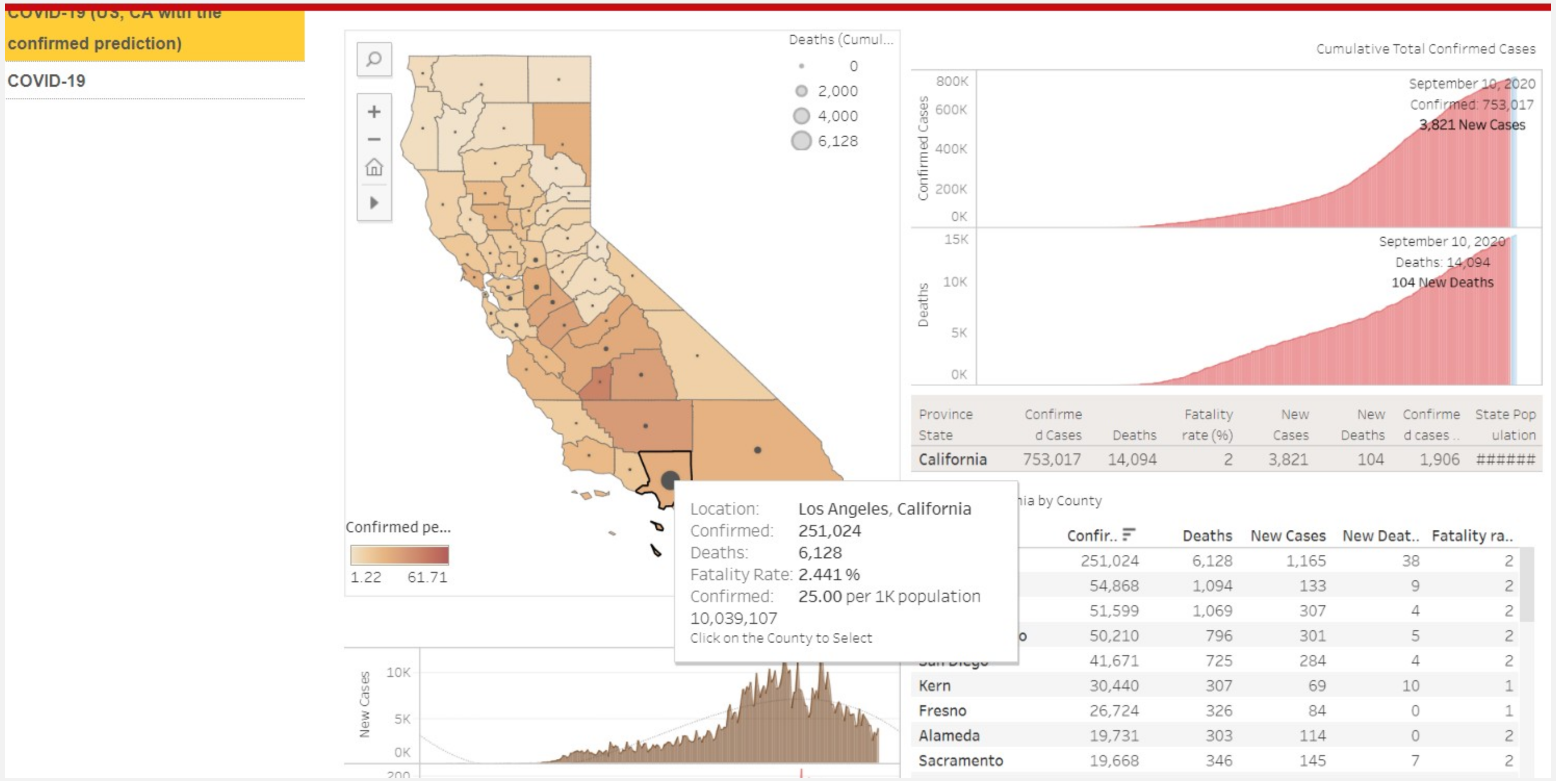
Results

- Predict Jams and other traffic incidents reported by users
  - in Dec 2017 – Jan 2018
  - Waze Traffic Data: > 20GB
    - From Device and Users
  - City of Los Angeles
  - Tempo-Spatial Analysis
  - Predictive Analysis
  - PySpark, Hadoop



Results

- COVID 19 Dashboard
  - Confirmed/Fatality cases
  - 3 days prediction
  - Tempo-Spatial Analysis and Prediction



Results

- Outstanding Paper Award received
  - Dalyapraz Dauletbak, Jongwook Woo, "Traffic Data Analysis and Prediction using Big Data", KSII The 14th Asia Pacific International Conference on Information Science and Technology (APIC-IST) 2019, pp127-133, ISSN 2093-0542

- Journal Papers indexed SCIE and SCOPUS
  (1) (Accepted, Oct 26, 2020) Monika Mishra, Jongwook Woo, "Predicting the Ratings of Amazon Products Using Big Data" in Wiley Interdisciplinary Reviews Data Mining and Knowledge Discovery, ISSN 1942-4795
  (2) D. Dauletbak and J. Woo, "Big Data Analysis and Prediction of Traffic in Los Angeles," KSII Transactions on Internet and Information Systems, vol. 14, no. 2, pp. 841-854, 2020. DOI: 10.3837/tiis.2020.02.021
  (3) Ruchi Singh and Jongwook Woo, "Applications of Machine Learning Models on Yelp Data", Asia Pacific Journal of Information Systems (APJIS), VOL.29 | NO.1 | March 2019, pp35~49, ISSN 2288-5404 (Print) / ISSN 2288-6818 (Online)
  (4) Priyanka Purushu, Niklas Melcher, Bhagyashree Bhagwat, Jongwook Woo, " Predictive Analysis of Financial Fraud Detection using Azure and Spark ML ", Asia Pacific Journal of Information Systems (APJIS), VOL.28 | NO.4 | December 2018, pp308~319, ISSN 2288-5404 (Print) / ISSN 2288-6818 (Online)

Results

- Campus News “Cal State LA researchers use data visualization, AI in fight against COVID-19” on April 2020
  - Recognized by Cal State LA President William A. Covino and EVP & Provost Jose A. Gomez
- Arirang TV:
  - Invited Interview about COVID-19
  - Aug 2020, Korea

  - Faculty Mentor Honoree of 2019 – 2020 at CBE, California State University Los Angeles

Lessons Learned

- Big Data AI (ML)
  - Linearly Scalable for large scale data set
  - High-Performance computing
- Big Data AI (DL)
  - Some data set works well with distributed deep learning
  - Some still works well with the traditional machine learning

Next Steps/Long-Term Plans

- Adopt various Distributed Deep Learning platforms
  - Including media data set: Video, Image, Audio
- Collaborate with Domain Experts in industry
  - Fraud Detection, AdClick
  - Time Series, Smart Things, Material Science
- Deliver and Enhance the course about Deep Learning and AI

Summary

- Big Data to store and compute large scale data set
  - Distributed Computing Systems
- Big Data Analysis and Prediction using Hadoop, Spark, Distributed Deep Learning
  - Big Data Science & Machine Learning & Deep Learning
- Various Domain needed

Artificial Intelligence and Human-Computer Interaction in Class-Based Projects

Franz J. Kurfess – Cal Poly, San Luis Obispo

Collaborators:

Faculty: Dr. Maria Pantoja (CP-SLO), Erin Sheets (CP-SLO); Dr. Chris Lowe (CSULB Shark Lab)
External Partners: Jingzhe Wu (World Bank), Dr. Elise St. John (DxHub), Dr. Gudrun Socher (Hochschule München University of Applied Sciences)
Students: see project slides

Franz J. Kurfess, Professor

Cal Poly, San Luis Obispo, Computer Science and Software Engineering

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Project Overview

Safety Assessment of School Buildings

- inspection of school buildings in developing countries by crowdsourcing image collection
- collaboration with Cal Poly's DxHub (Dr. Elise St. John) and the World Bank's Global Program for Safer Schools (GPSS; Jingzhe Wu)
- planned collaboration with Hochschule München - University of Applied Sciences disrupted by COVID-19 (Dr. Gudrun Socher)
- Winter 2020: CSC 580 Artificial Intelligence (grad. class), CSC 486 Human-Computer Interaction
- Fall 2020: CSC 480 Artificial Intelligence

Shark Spotting with Drones

- application of Deep Learning methods to identify sharks in drone video footage
- collaboration with the Shark Lab at CSU Long Beach (Dr. Chris Lowe, Patrick Rex)
- Fall 2019: CSC 480 Artificial Intelligence, CSC 487 Deep Learning (Dr. Maria Pantoja)
- Summer 2020: College of Engineering Summer Undergraduate Research Program
- Fall 2020: CSC 480 Artificial Intelligence

CAL POLY

Safety Assessment of School Buildings

- inspection of school buildings in developing countries by crowdsourcing image collection
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- Fall 2020: CSC 480 Artificial Intelligence

THE WORLD BANK

Global Program for Safer Schools (GPSS)

Safety Assessment of School Buildings

Designing with Community Citizen Science

Yen-Chia Hsu and Illah Nourbakhsh. 2020. When human-computer interaction meets community citizen science. Commun. ACM 63, 2 (February 2020), 31–34. DOI:https://doi.org/10.1145/3376892

Citizen Science: empowers amateurs and professionals to form partnerships and produce scientific knowledge jointly.

+ **Professionals lead** projects and the public is encouraged to join

Community Citizen Science: a particular case of citizen science that embraces participatory democracy, **community co-design**, and power rebalance.

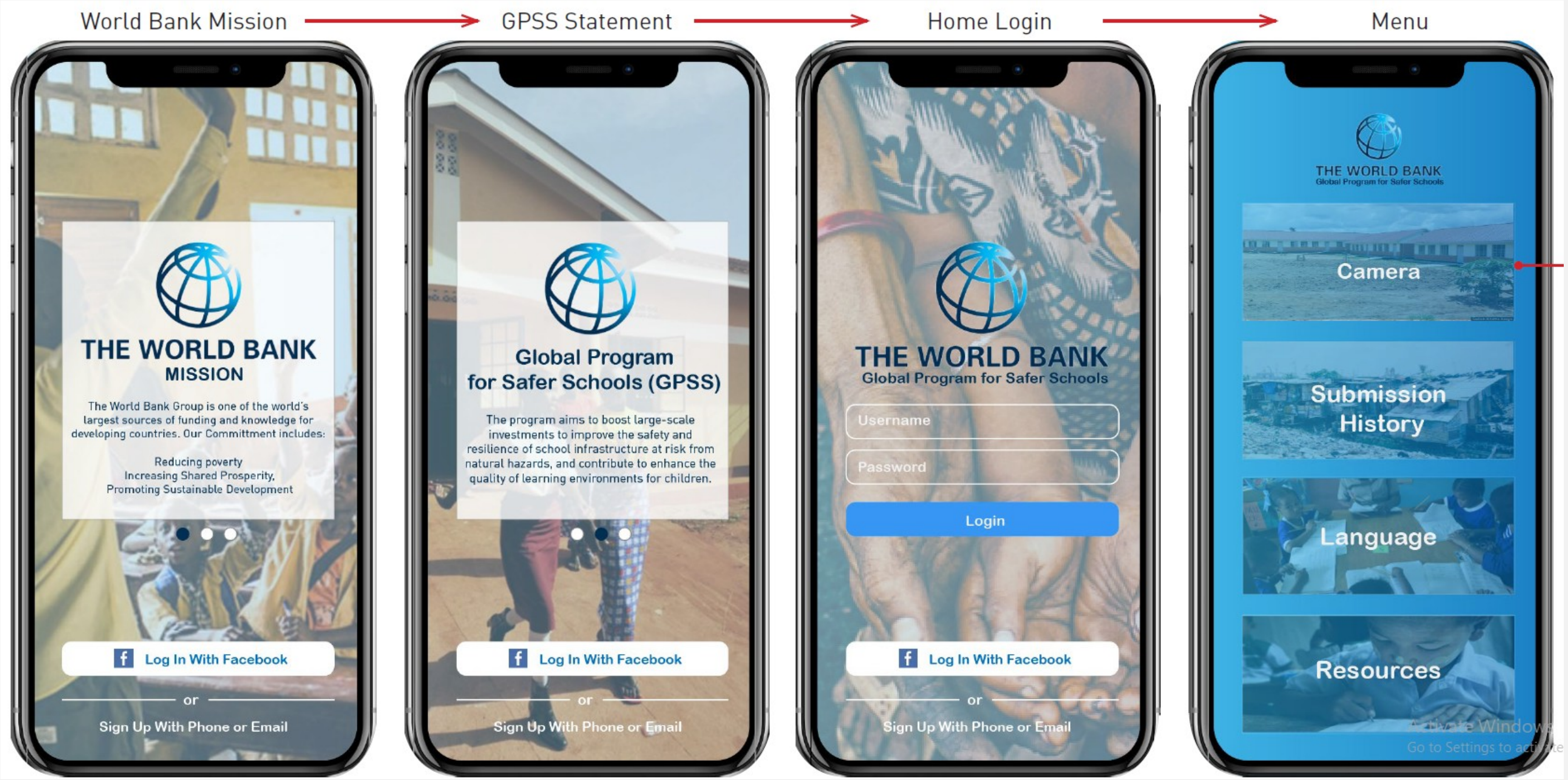
+ **Incorporating communities** into project design and evaluation

AI and HCI in Class-Based Projects

Safety Assessment of School Buildings

Home Screen and Authentication

- background information
- login
- home menu
    - camera
    - submission history
    - language
    - resources



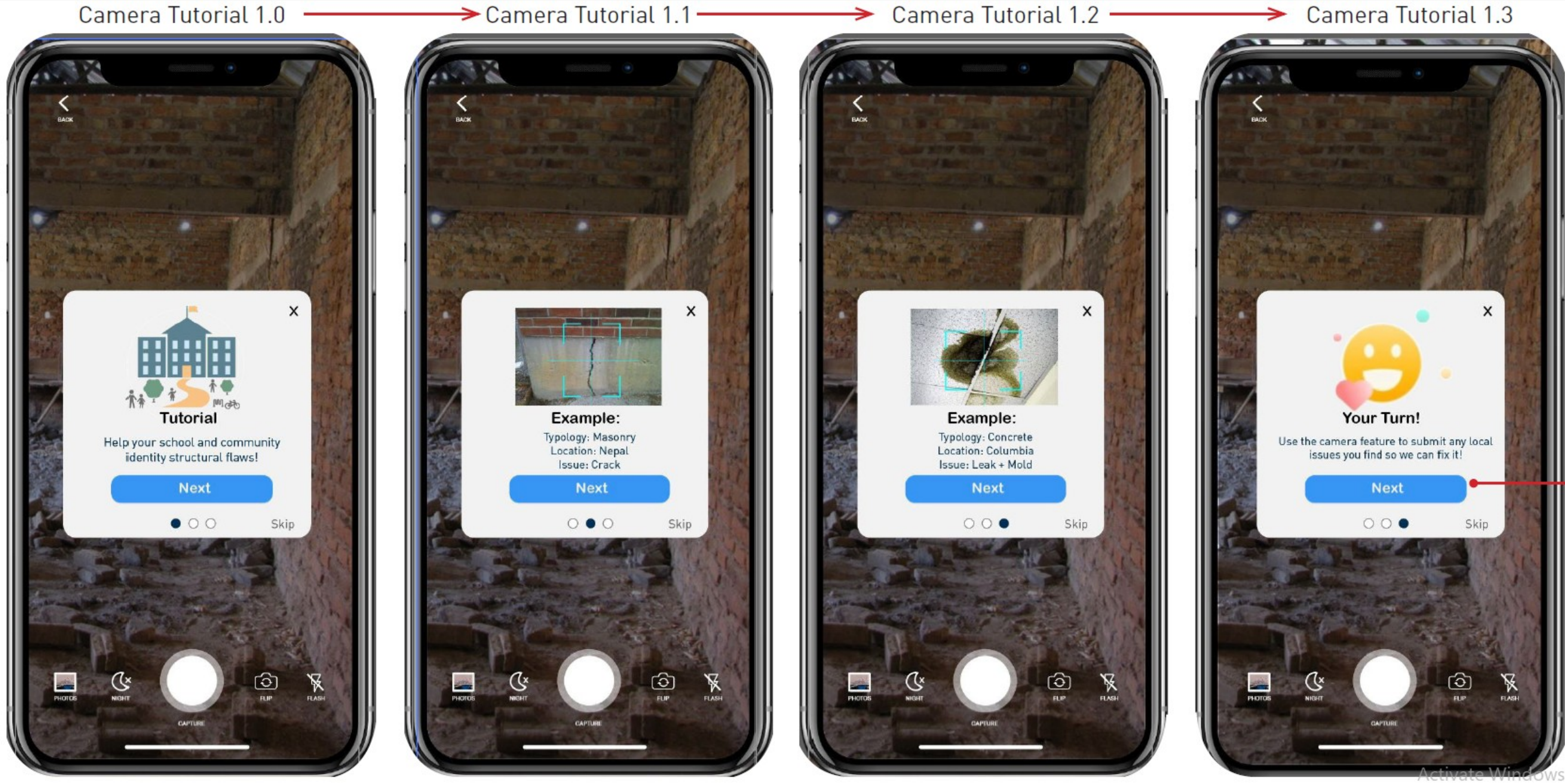
Franz J. Kurfess *Cal Poly, San Luis Obispo/CSSE* *fkurfess@calpoly.edu*

AI and HCI in Class-Based Projects

Safety Assessment of School Buildings

Camera Capture, AI Suggestions, Reporting

- purpose
- explanations
- examples
- move to the next action



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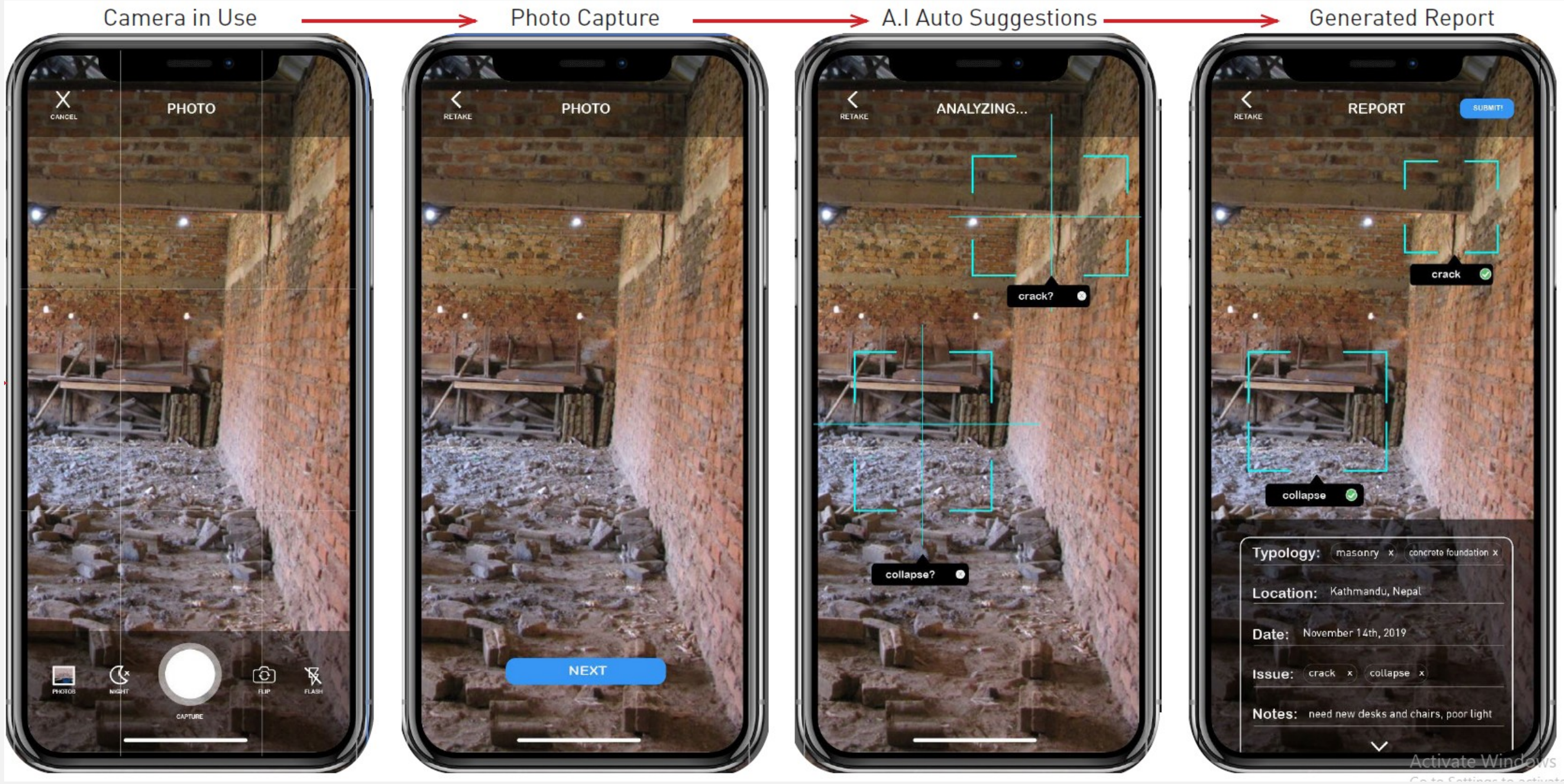
AI and HCI in Class-Based Projects

Safety Assessment of School Buildings

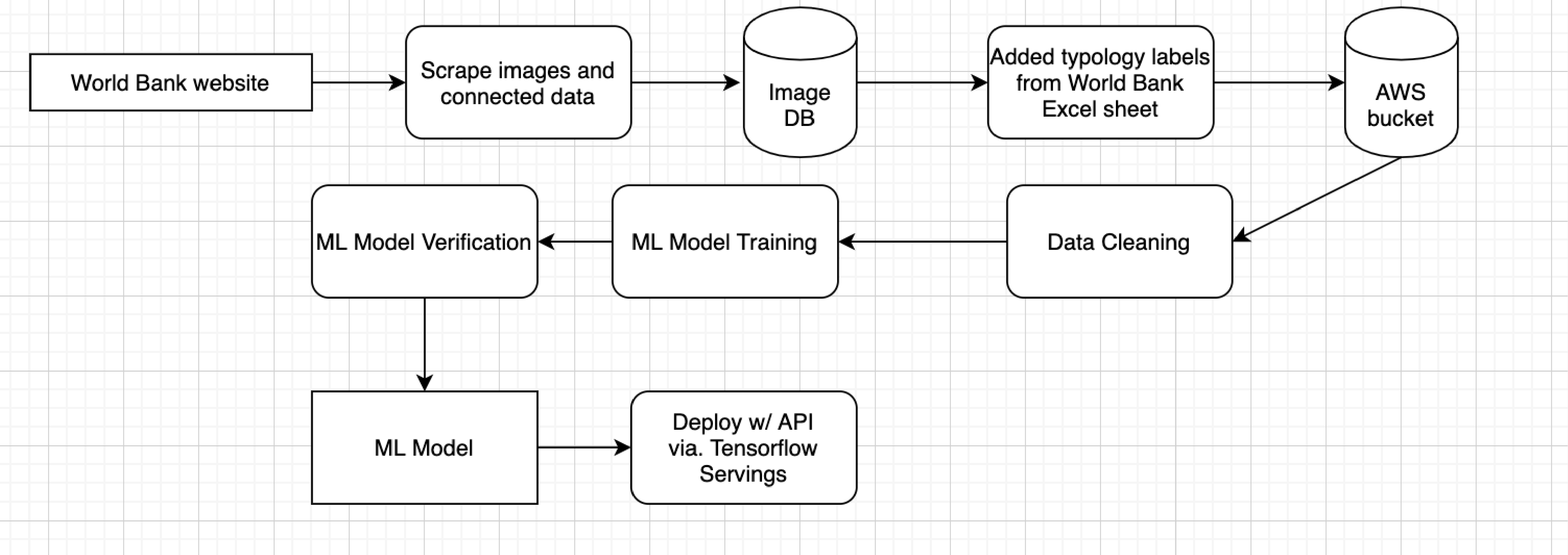
Camera Capture, AI Suggestions, Reporting

- user takes picture
- AI performs an initial analysis of the picture and indicates improvements
- picture with metadata is uploaded to the repository



Franz J. Kurfess Cal Poly, San Luis Obispo/CSSE fkurfess@calpoly.edu

Safety Assessment of School Buildings



Block Diagram for AI Project Components

LEARN BY DOING CAL POLY

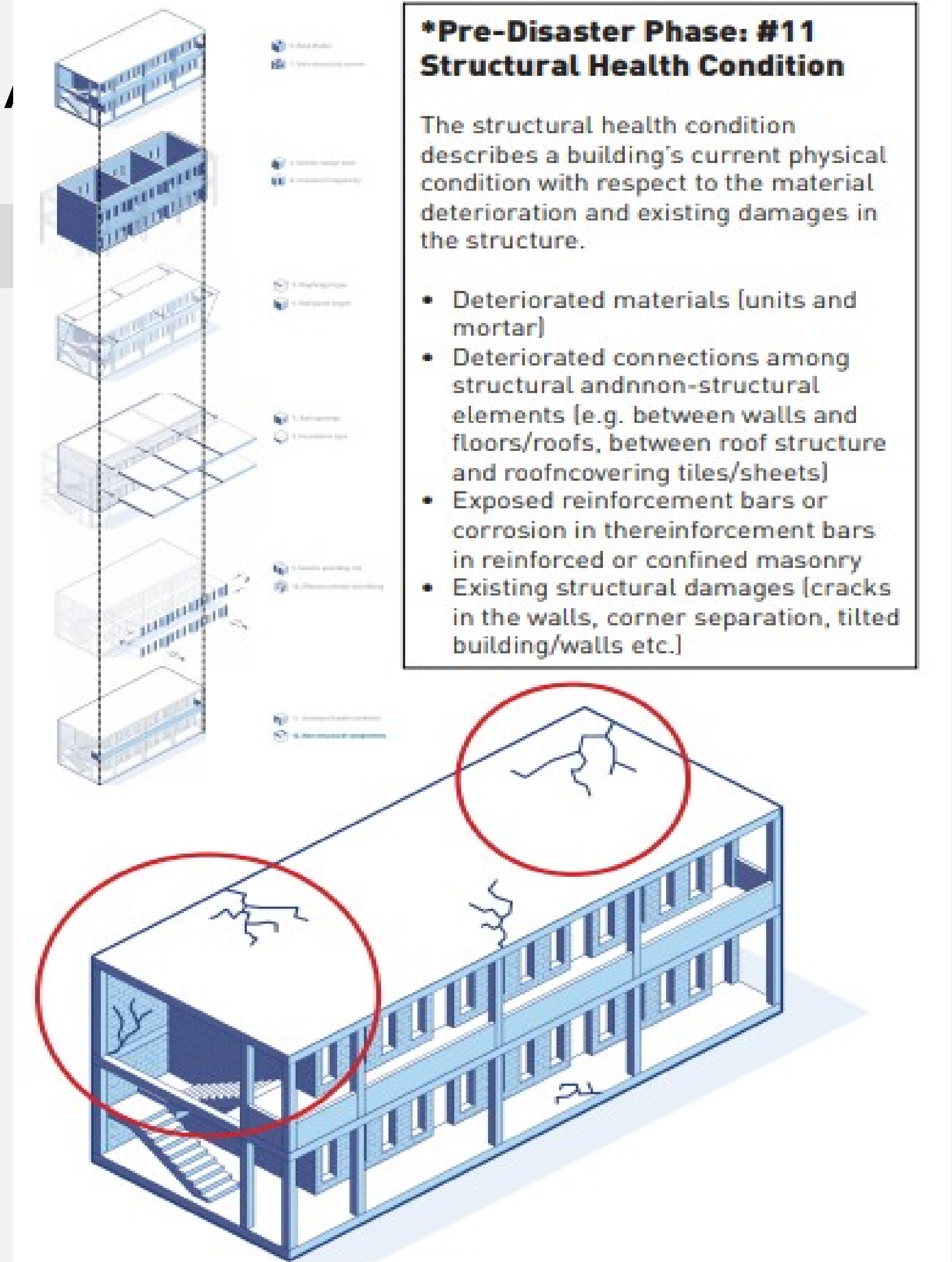
Safety Assessment of School Buildings

Building Assessment

- images of buildings in the repository are analyzed
- training of a computational model through Deep Learning on annotated sample images
  - Xception, InceptionResNetV2, with Keras and Tensorflow
  - Google Colab and Amaon AWS/EC2 via DxHub
- application of the model to new images
- input for structural engineers to aid in their decision making

Model Validation

- access to the World Bank repository for the AI team was a challenge
- decent performance (67%-95%) on different features (structural system: 65%; height: 95%; 81: building type) for a subset of the structural types of buildings
  - LBM: Load-bearing masonry
  - SF: Steel Frame
  - TF: Timber Frame
  - RC: Reinforced concrete



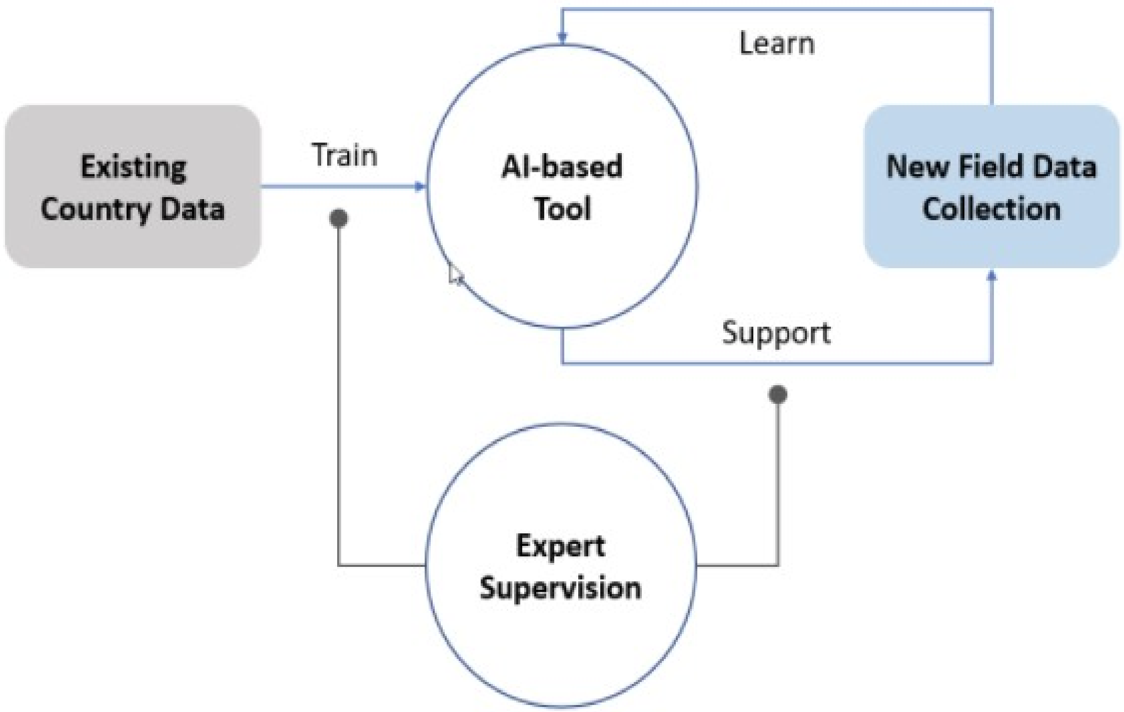
Safety Assessment of School Buildings

Planned Work Spring/Summer 2020

- hand-over of the user interface and AI components to student teams in a Spring 2020 Mobile Development class at Hochschule München, University of Applied Sciences
- trip to Munich during 2020 Spring Break by four student representatives and an instructor
- cancelled days before departure due to COVID-19

Ongoing Work Fall 2020, Winter 2021

- expansion of the AI components
  - include more building types
  - improve performance
- integration of AI and HI components



Results

Safety Assessment of School Buildings

- Neural Networks that categorize school buildings according to building types and structural health condition
- Software tool to improve data collection with the help of local residents
- Increased efficiency of World Bank personnel
  - less travel by building inspector
  - easier assessment
  - increased quantity and quality of collected data sets (images)

⇒ Safer School Buildings

CAL POLY

AI and HCI in Class-Based Projects

Safety Assessment of School Buildings

CSC 580-W20 Artificial Intelligence (Grad. Class)

- building classification
  - **Team 8 Safety First**: Ian Atol, Stephen Hung, Dmitriy Timokhin, Hanson Egbert, Donnie Sanchez, Anurag Uppuluri
- collaborators:
  - World Bank: Jinzhe Wu
  - DxHub: Dr. Elise St. John

CSC 486-W20 Human-Computer Interaction

- citizen science and data collection app design
  - **Team 4 H-C-Eye On The Prize**: Nathan Tu, Matthew Patacsil, Sydney Nguyen, Andre Viloria, Josh King, Gabriel Medina-Kim
- collaborators:
  - World Bank: Jinzhe Wu
  - DxHub: Dr. Elise St. John,

CSC 486 Summer 2020 (Erin Sheets)

- improved user interaction
  - student team members:
- collaborators:
  - World Bank: Jinzhe Wu
  - DxHub: Dr. Elise St. John,

CSC 480-F20 Artificial Intelligence

- expansion to additional building structures
  - **Team 2 Better Buildings**: Julian Rice, Eric Newcomer, Steven Le, Ziyi Wang, Finlay Piroth, Sveta Selvan, Martin Jiang
- collaborators:
  - World Bank: Jinzhe Wu
  - DxHub: Dr. Elise St. John, Elisa Horta, Heidi Glunz

CAL POLY

LEARN BY DOING

Shark Spotting with Drones

Motivation

- detecting the presence of sharks in coastal waters also used by surfers, swimmers, boaters, …
- behavioral analysis of sharks

Approach

- analyze video footage from drones to detect objects of interest such as sharks, seals, tuna, humans, boats, …
- train a computational model to detect and classify such objects

Goal

- alert lifeguards and users to the presence of sharks
- real-time analysis of drone footage

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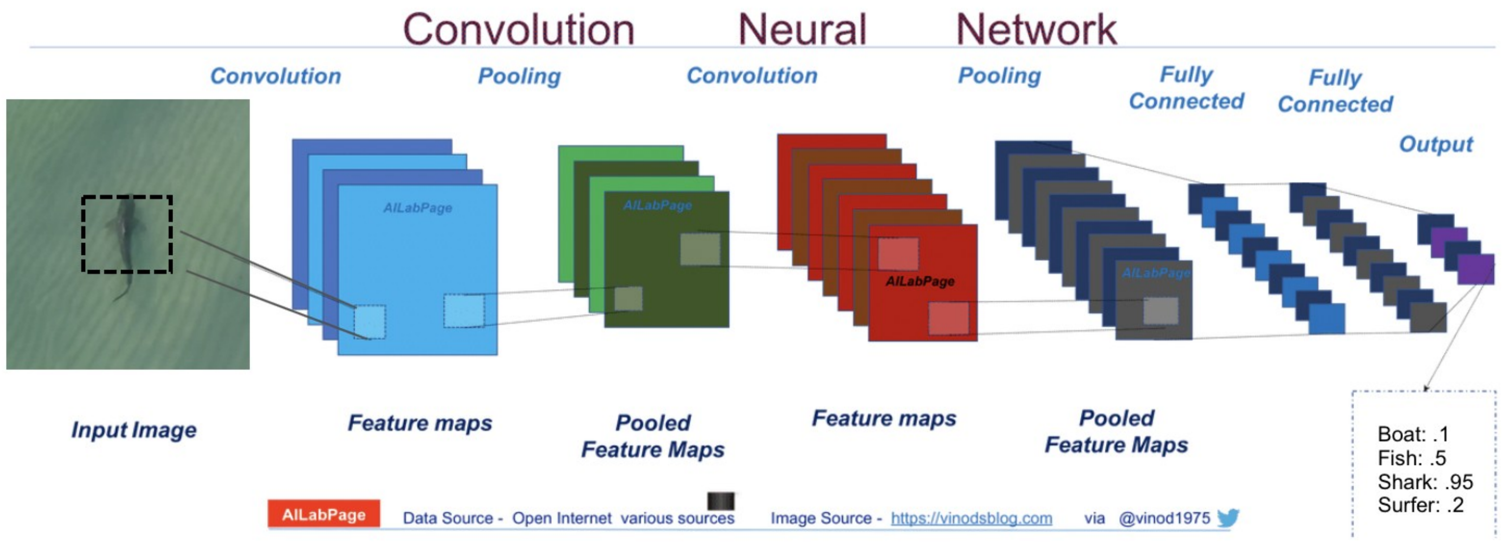
AI and HCI in Class-Based Projects

Shark Spotting with Drones

Image Labeling

- domain experts label images
  - draw box around object of interest
  - assign label to object



Object Classification

- ImageAI open-source library in Python
  - Deep Learning
  - Computer Vision
- transfer learning based on YOLO v3
  - pre-trained model for object detection and classification

CAL POLY
LEARN BY DOING

AI and HCI in Class-Based Projects

Shark Spotting with Drones

CSC 480-F19 Artificial Intelligence

- early proofs of concept
  - **Team 3 Baby Sharks**: Nicky Kyono, Allison Erin, Roxanne Miller, Teja Kalvakolanu, Scott Rizzo, Luis Trujillo
  - **Team 15 The Sharks**: Ryan Kirkpatrick, Gabriel Marquez, Connor Virostek, Fridtjof Alestrom

CSC 487-F19 Deep Learning (Dr. Maria Pantoja)

- early proof of concept
  - **Team Shark Spotting**: Michael Pangburn, Gregory Chu, Aaron Rice, Kevin Krein, Juan Salazar, Patrick Kramer

Summer Undergraduate Research Project - SURP 2020

- ~4,000 additional labeled images, improved performance; real-time object recognition
- sponsors: Nic and Sara Johnson
  - Web site sites.google.com/view/sharkspotting; SURP 2020 Shark Spotting Video on Youtube
  - student team members: Kathir Gounder, Grace Nolan, Daniel Moore, Caroline Skae, Casey Daly, Damon Tan

CSC 480-F20 Artificial Intelligence

- expansion to humans on the beach
  - **Team 6 Better Lighting**: Joshua Boe, Polina Volnuhina,Tyler Tencati, Brian Tsai
- expansion to humans on the beach
  - **Team 15 Sharks vs Humans**: Karla Sunjara, William Hickman, Ryan Premi, Daniel Yim

CSU Long Beach Shark Lab

- domain expertise
- drone video footage
  - **Dr. Chris Lowe (director)**
  - Patrick Rex (grad student)

Results

Shark Spotting with Drones

- Neural Networks that distinguish sharks from other objects in video footage
  - seals, surfers, boats, swimmers, …
- Data set of ~4,500 labelled images of sharks and other objects in drone video footage
- Software tool to improve workflow for Marine Biology students at the CSULB Shark Lab
- Basis for tracking the movement of sharks
  - behavioral modeling of sharks
  - interactions between sharks and humans

Lessons Learned

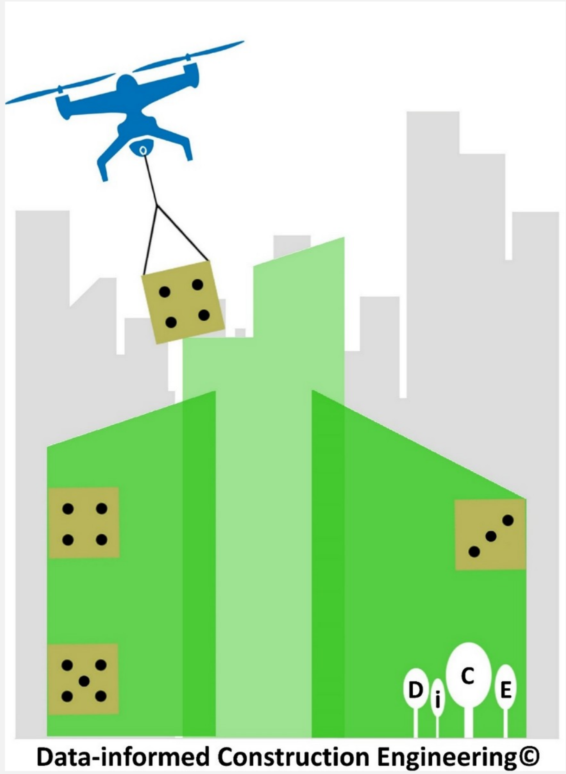
- **Strong student motivation**
  - work on real-world projects with potential for significant impact
  - collaboration with on-campus and external partners
- **Rewards and drawbacks of collaboration**
  - expanded scope of opportunities for students, often at crucial stages in their career and personal life
  - basis for ongoing activities
  - requires preparation, incurs overhead, and not all projects go well
  - coordination with external partners can be time-consuming
- **Transitions can be hard**
  - end of term = end of project for many students => emphasis on documentation
  - changes at partners can cause problems

Summary

- **Research at teaching-focused institutions is feasible**
  - emphasis on hands-on, practical activities that are amenable to modularization
  - motivated and talented students are an invaluable resources
  - external partners add opportunities, provide additional resources, but may also increase complexity
- **External funding is good, but not always critical**
  - both example projects were conducted with no (School Safety) or minimal funding (~$10,000 for Shark Spotting)
  - can be the basis for applications to take the work to the next level

Artificial Intelligence in Construction Engineering

Reza Akhavian – San Diego State University

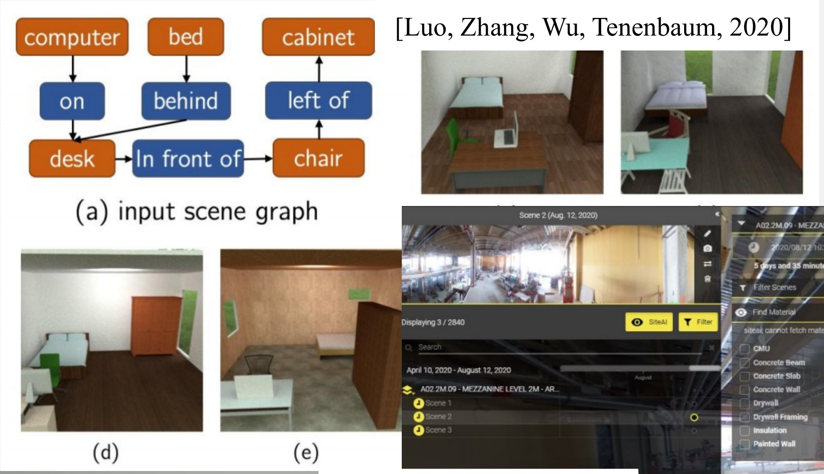


Reza Akhavian, Assistant Professor
San Diego State University (SDSU), Department of Civil, Construction, and Environmental Engineering
rakhavian@sdsu.edu

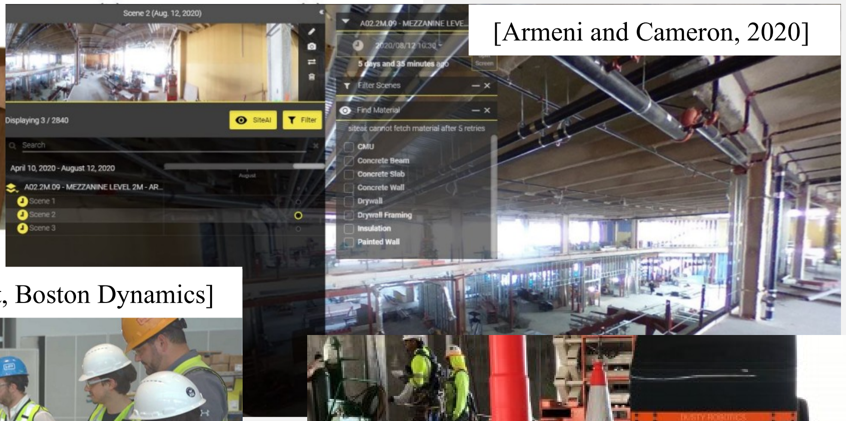
San Diego State University

Applications of AI in the Construction Industry

- **Challenges:**
  - High accident and injury rates
  - Stagnant productivity
  - Shortage of skilled workforce
- **AI-enabled solutions:**
  - Design automation and optimization
  - Visual progress monitoring
  - Robotics
  - ***Worker/equipment activity analysis***



[Luo, Zhang, Wu, Tenenbaum, 2020]



[Armeni and Cameron, 2020]

[Spot, Boston Dynamics]

[Dusty Robotics]

SAN DIEGO STATE UNIVERSITY

Construction Equipment Activity Analysis Using Deep Learning

Problem: Low Productivity

Lowest productivity occurs during the **initial phases** of construction projects when **heavy equipment use is highest**

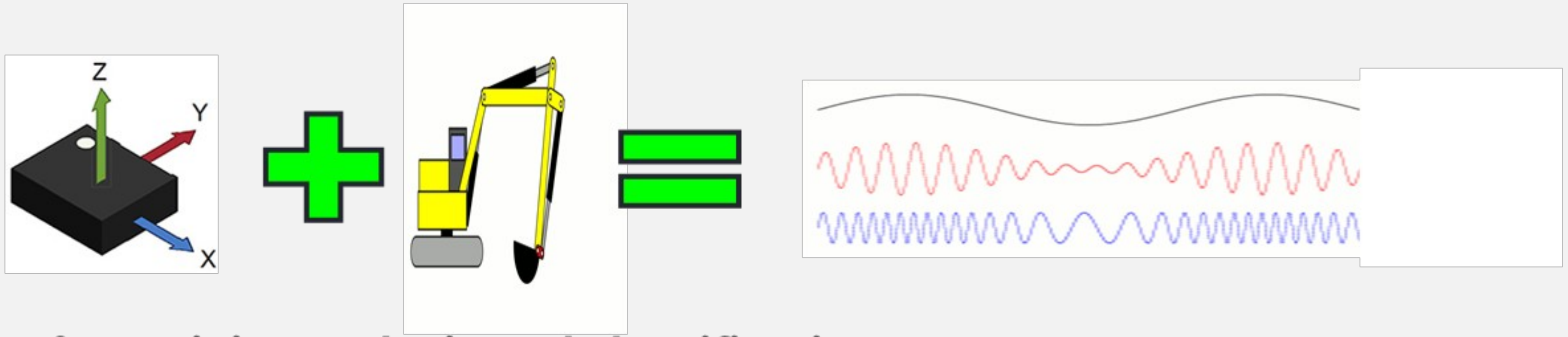
Contributors to Low Productivity:

- Long or frequent equipment idle times
- Other non-value-adding activities

Construction Equipment Activity Analysis Using Deep Learning

Our Work: Improved Activity Tracking

Accelerometer sensors for activity detection

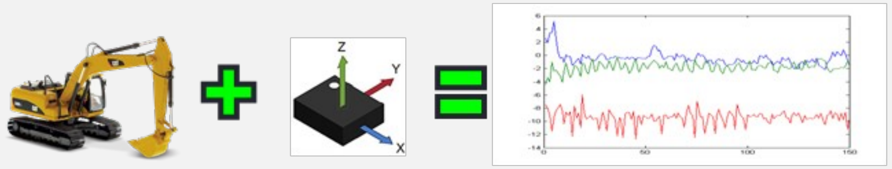


Deep learning for activity analysis and classification

Construction Equipment Activity Analysis Using Deep Learning

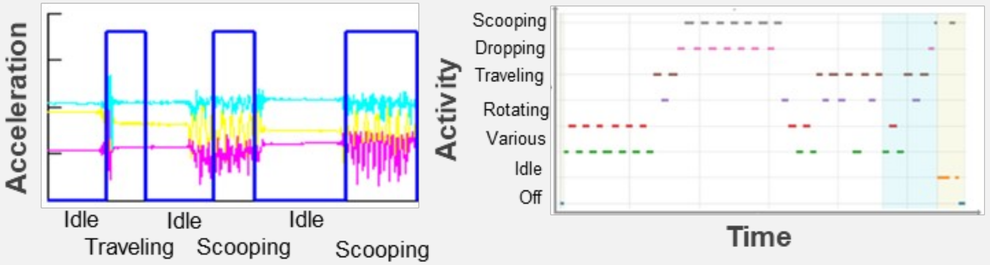
Developed Methodology

1. Collect data from construction equipment performing real work

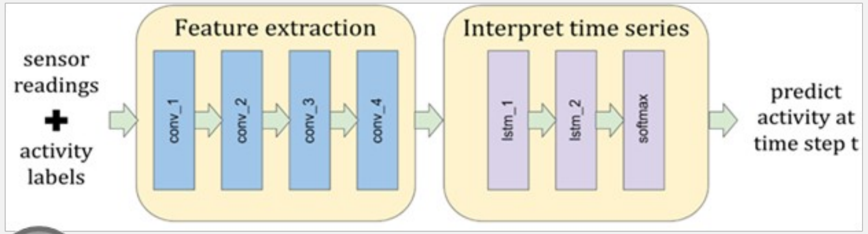


Machine Accelerometer Signature Activity Patterns

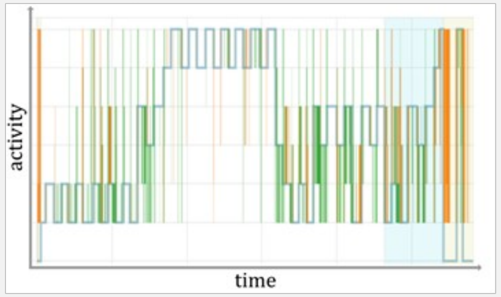
2. Manually label equipment activities



3. Train predictive model with deep learning



4. Classify future activities

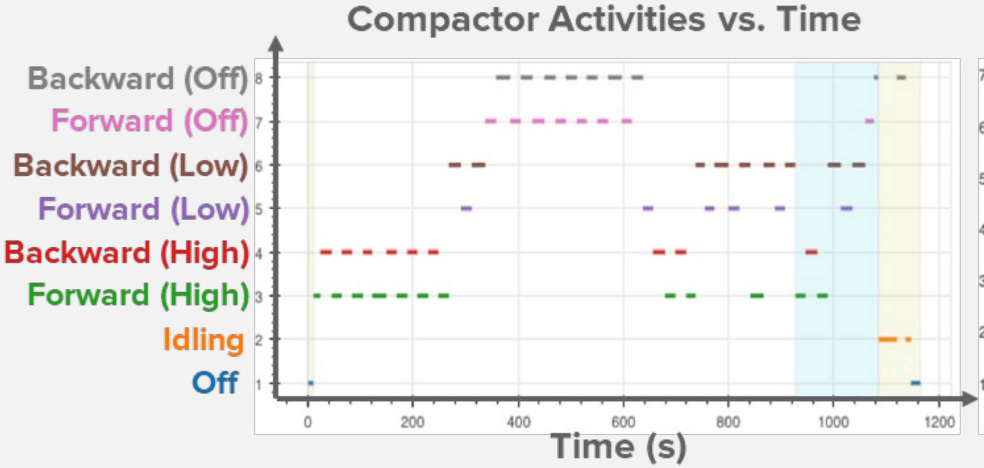


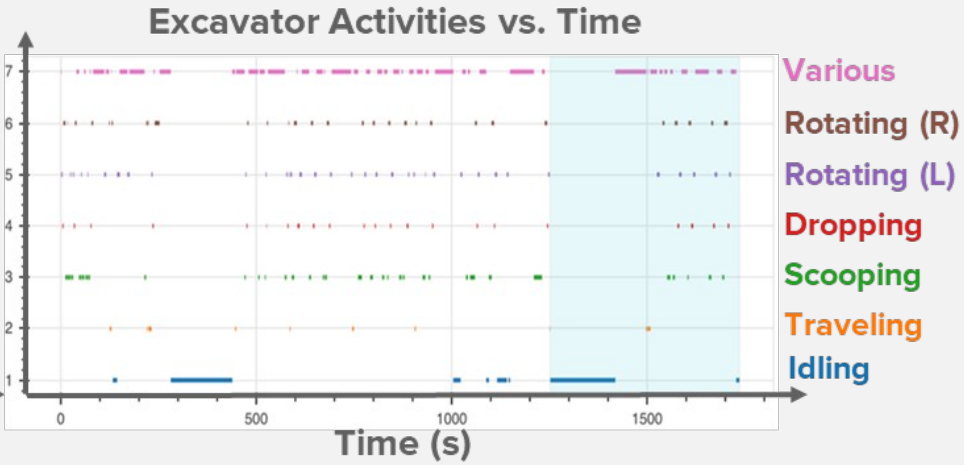
5. Cut unproductive activity patterns (and related GHG emissions)

Construction Equipment Activity Analysis Using Deep Learning

Real-World Data Collection

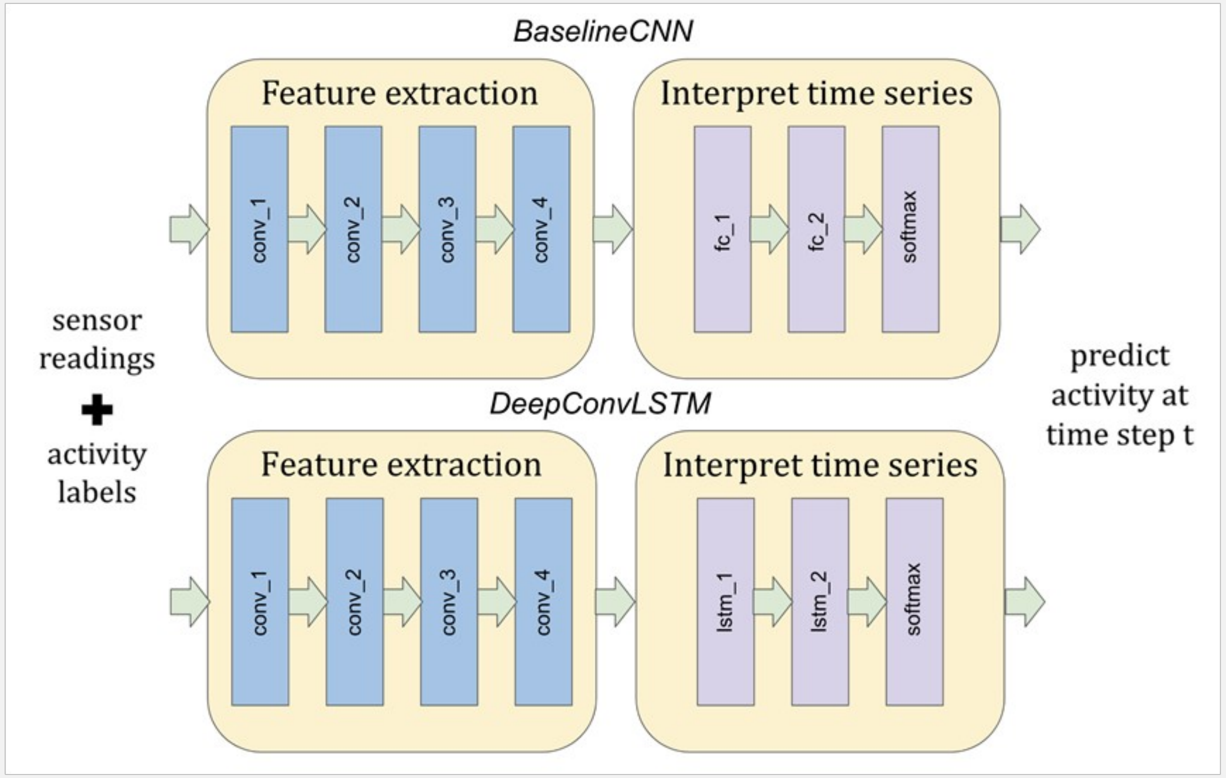
- Machines performed real construction work
- Two 3-axis accelerometers @100 Hz
- Six channels sensor readings





Construction Equipment Activity Analysis Using Deep Learning

Models



- Four convolutional layers with 64 learnable filters each form the feature extraction blocks
- *BaselineCNN* uses feed-forward layers to classify activities
- *DeepConvLSTM* uses recurrent layers to classify activities

Construction Equipment Activity Analysis Using Deep Learning

Results

- Compactor results: DeepConvLSTM > BaselineCNN
- Confusion matrix: excavator mostly confused by *Various*
- Removing *Various* increased performance considerably

Experiment	BaselineCNN	DeepConvLSTM
Compactor activities (6)	74.2%	77.1%
Compactor direction (2)	93.6%	96.2%
Compactor vibration (3)	74.4%	75.2%
Excavator activities (7)	N/A	77.6%
Exc. no *Various* (6)	N/A	**90.7%**

(a) Full data set

Predicted \ Actual	Idling	Traveling	Scooping	Dropping	Rotating (left)	Rotating (right)	Various
Idling	16731	14	130	0	305	0	110
Traveling	0	202	0	0	33	22	668
Scooping	172	0	2006	70	0	38	404
Dropping	0	0	2	1116	123	24	440
Rotating (left)	0	13	0	78	2063	172	470
Rotating (right)	0	0	152	158	92	2582	252
Various	1726	251	3917	272	401	315	12711

(b) No Various

Predicted \ Actual	Idling	Traveling	Scooping	Dropping	Rotating (left)	Rotating (right)
Idling	16566	6	694	0	24	0
Traveling	0	529	168	31	155	42
Scooping	0	0	2593	14	39	44
Dropping	0	0	15	1104	561	25
Rotating (left)	0	0	32	95	2602	67
Rotating (right)	0	0	187	81	377	2591

Construction Equipment Activity Analysis Using Deep Learning

Ongoing Work

- Collecting data with Portable Emissions Measurement System (PEMS)
- Studying emissions-activity patterns
- Studying model generalization across populations of machines/operators

PEMS

Current and Future Research – Collaborations Welcome!

- **Applications of AI to:**
  - *Promote and facilitate human-robot interaction in construction*
  - *Determine the drivers of trustworthy robotics in construction*
  - *Monitor occupational health and stress using wearable sensors to address health disparities in construction*
  - *Enhance construction work zone safety via automated video and smartphone data analysis*

Acknowledgement

Current students:

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Binh Pham

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- Caltrans
- US DoT (Safe-D National UTC)
- Hedco Foundation
- DPR Construction
- Bentley Systems

Alumni:

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Next Steps/Closing Remarks

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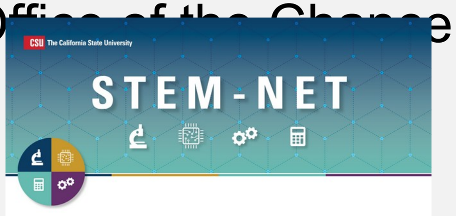
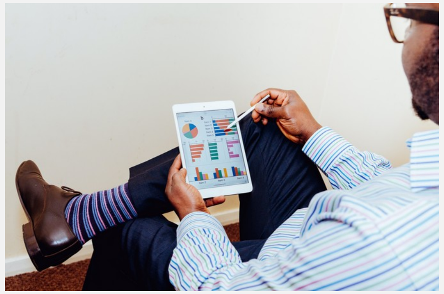
Executive Director, STEM-NET
Office of the Chancellor



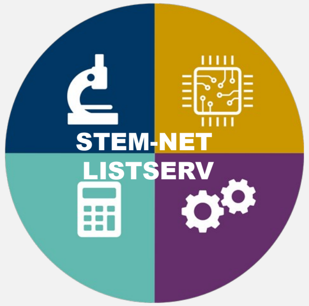
https://www2.calstate.edu/impact-of-the-csu/research/stem-net

STEM-NET COMMUNITY & FEEDBACK



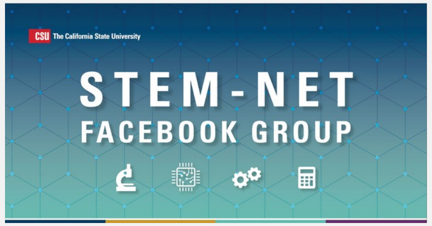
Webcast Feedback Survey

Please take a few moments to tell us about your webcast experience
https://forms.gle/AyvNGm17irP8Yffg7



Join our CSU STEM-NET Community listserv

csustemnet@lists.calstate.edu



Begin a Conversation with Colleagues and Join our Private CSU STEM-NET Facebook Group

https://www.facebook.com/groups/2629611737269292

Frank A. Gomez *CSU Office of the Chancellor* *fgomez@calstate.edu*

STEM-NET Upcoming Events

Register Today and Join Us

STEM-NET Conversations

Managing Research, Teaching (and Life) in the CSU in the Time of COVID-19
Thursday, December 3rd "@ 2pm-3:30pm

Register Here: https://tinyurl.com/yyorf4rm

STEM-NET December Webcast

"Exemplars in Biology"
Thursday, December 10th "@10am-12pm

Register Here: https://forms.gle/if6zTGnKPFgVXCgcA

Save the Dates

Registration Opens Soon

“CSU Exemplars in the NSF Improving Undergraduate STEM Education (IUSE) Program”

Thursday, February 4th @ 10 A.M.-12 P.M

Frank A. Gomez *CSU Office of the Chancellor* *fgomez@calstate.edu*