Computer Vision: **Using Satellite images to infer AQI in California**

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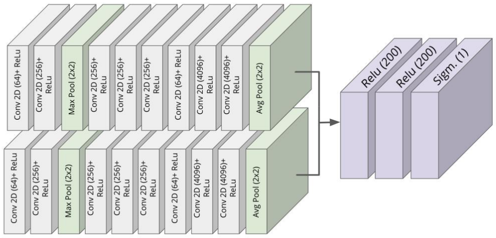
Motivation

- The applications of satellite imagery in deep learning are widespread (crop yield prediction, poverty prediction, etc.)
- Precise AQI[1] readings are sparse (especially in remote areas).
- **Goal:** train a deep neural network to predict difference in AQI given two satellite images from the same location but different times.

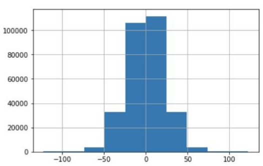
Model

- **Siamese Network:** Two parallel, pre-trained image vector representations[2]. This neural network contains 8 convolutional layers
- **Customized Prediction Head:** Three untrained layers with single output unit



Evaluation (Baseline)

- **Intuition** hails from human performance
- **Rationale:** Humans guess random based on their knowledge about the outcome distribution.
- **Baseline MSE:** 1231.53.



Data

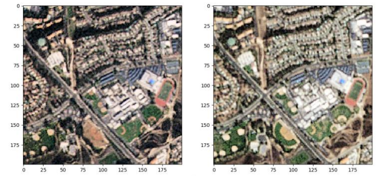
Daily AQI Readings

Date	Daily AQI	...	SITE_LAT	SITE_LONG
01/01/19	40	...	37.687526	-121.784217
01/02/19	32	...	37.687526	-121.784217

Monthly Satelite Imagery

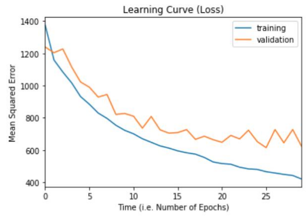
Keras Sequence API

- **Training set:** approx. 300,000 image pairs
- **Test set:** 18,900 image pairs



AQI Delta: 41.0

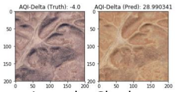
Results



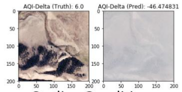
Train MSE:	Val. MSE:	Test MSE:
421.13	**615.21**	**1041.38**

Future Work

- **Insight from error analysis:** high validation error can be attributed to wide variety of contextual image conditions, for instance

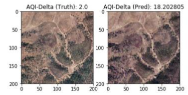


Irregular Shades



Outlier Conditions

Extraneous topologies



Optimizing the Learning Process

- **Learning Speed:** Parallelization and freezing pre-trained layers made training faster (>10x speedup)
- **Countering Overfitting:** Adding dropout layers and re-sampling the training data kept training and validation error close
- **Improving Predictions:** Using a deeper network, scaled sigmoid activation, and "skewed" training data yielded meaningful predictions faster.

References

[1] United States Environmental Protect Agency, "Air Quality Index (AQI) Basics." https://www.airnow.gov/index.cfm?action=aqibasics.aqi. [Online; accessed 30-April-2019].
[2] N. Jean, M. Burke, M. Xie, W. M. Davis, D. B. Lobell, and S. Ermon, "Combining satellite imagery and machine learning to predict poverty," Science , vol. 353, no. 6301, pp. 790–794, 2016.
[3] M. Kubat, R. C. Holte, and S. Matwin, "Machine learning for the detection of oil spills in satellite radar images" Machine learning, vol. 30, no. 2-3, pp. 195–215, 1998.
[4] X. E. Pantazi, D. Moshou, T. Alexandridis, R. L. Whetton, and A. M. Mouazen, "Wheat yield prediction using machine learning and advanced sensing techniques," Computers and Electronics in Agriculture, vol. 121, pp. 57–65, 2016.