



# The Dusk of Survey Data and the Dawn of Aerial Imagery in Economics: Cost-efficient housing price learning in the developing world



Alexandr Lenk, Matias Cersosimo, Rodrigo Naumann

Stanford University

## MOTIVATION

Urban landscape in developing countries is under constant economic and physical transformation. Housing prices both react to and stimulate this process.

Predicting rents can be a valuable tool for the study of the evolution of spatial and social neighborhood heterogeneity and for the design of efficient urban policies.

Survey data on neighborhood characteristics is logistically and financially more expensive compared to drone data, particularly in repeated intervals.

## DATA AND RAW FEATURES

Household Survey Data from World Bank (dwelling amenities and neighborhood characteristics).

21 Drone Image Blocks of Dar-el-Salam (Tanzania) – 7cmx7cm by pixel



## MODEL: DEEP FEATURES, TRANSFER LEARNING AND FINE-TUNING

Idea: Efficiently capture tangible and intangible housing features.

Method: Feature extraction using transfer learning and fine-tuning of a DCNN.

Initial Learning Task: Classification of houses as expensive, medium and cheap.

Algorithm: SoftMax using *Inception v3* (partially pretrained on Imagenet).

Input: 498 extracted images (radii of 10m and 40m around house GPS coordinates).



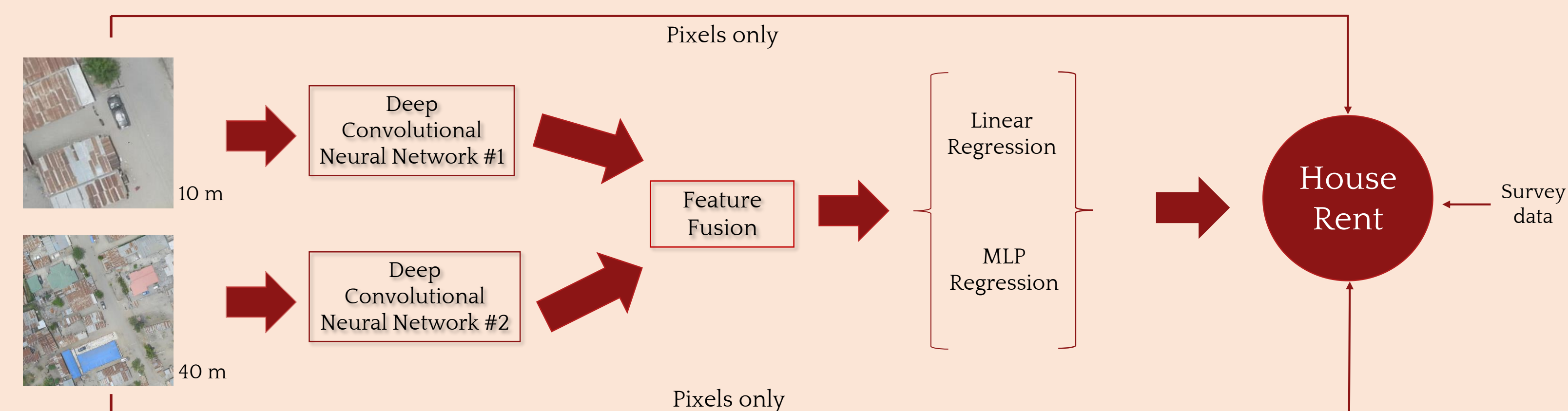
Fine-tuning: Last convolutional block + last fully connected layer.

Features extracted from the classification task: 11 (cross-validated on 5:3:35).

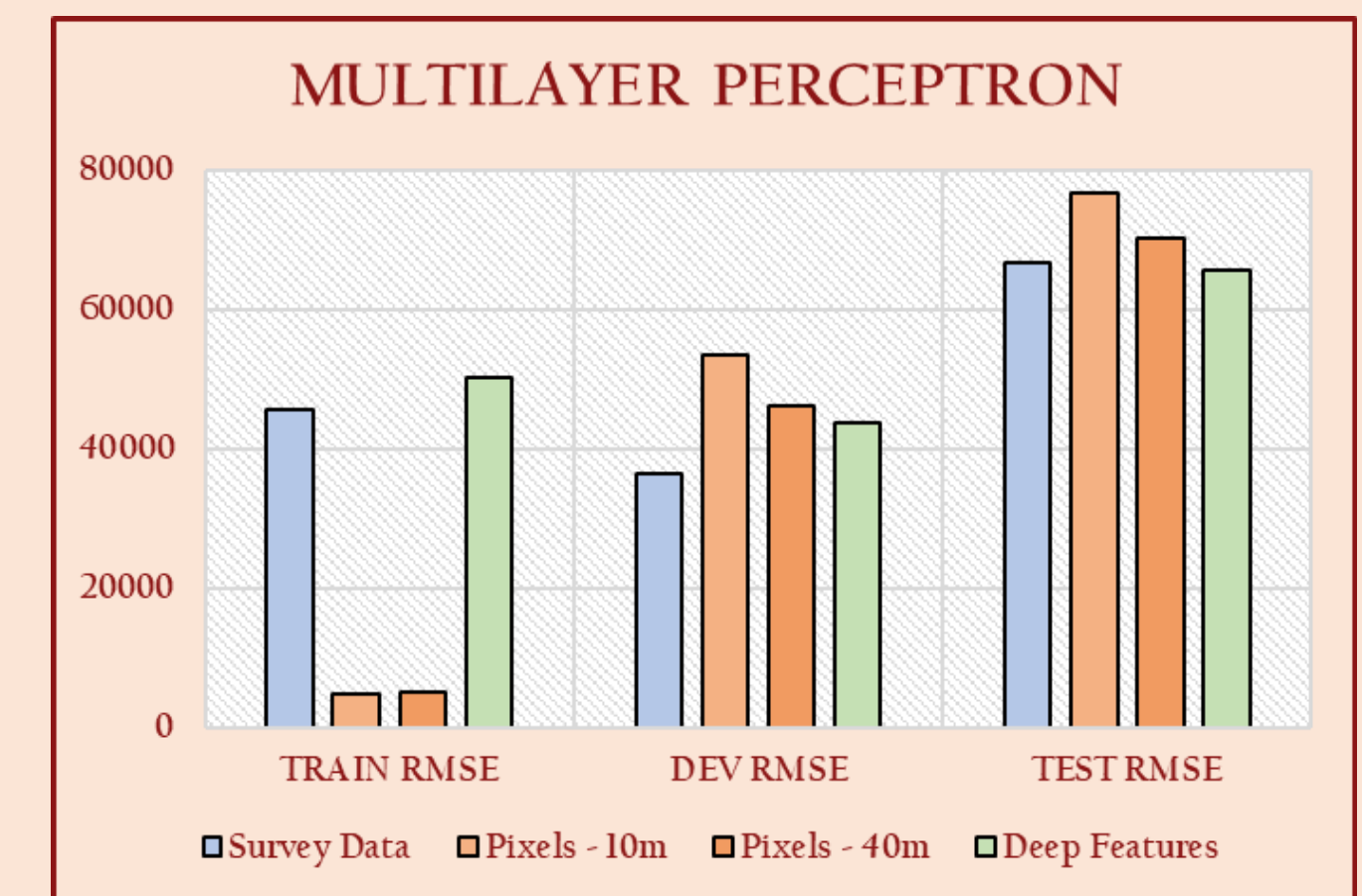
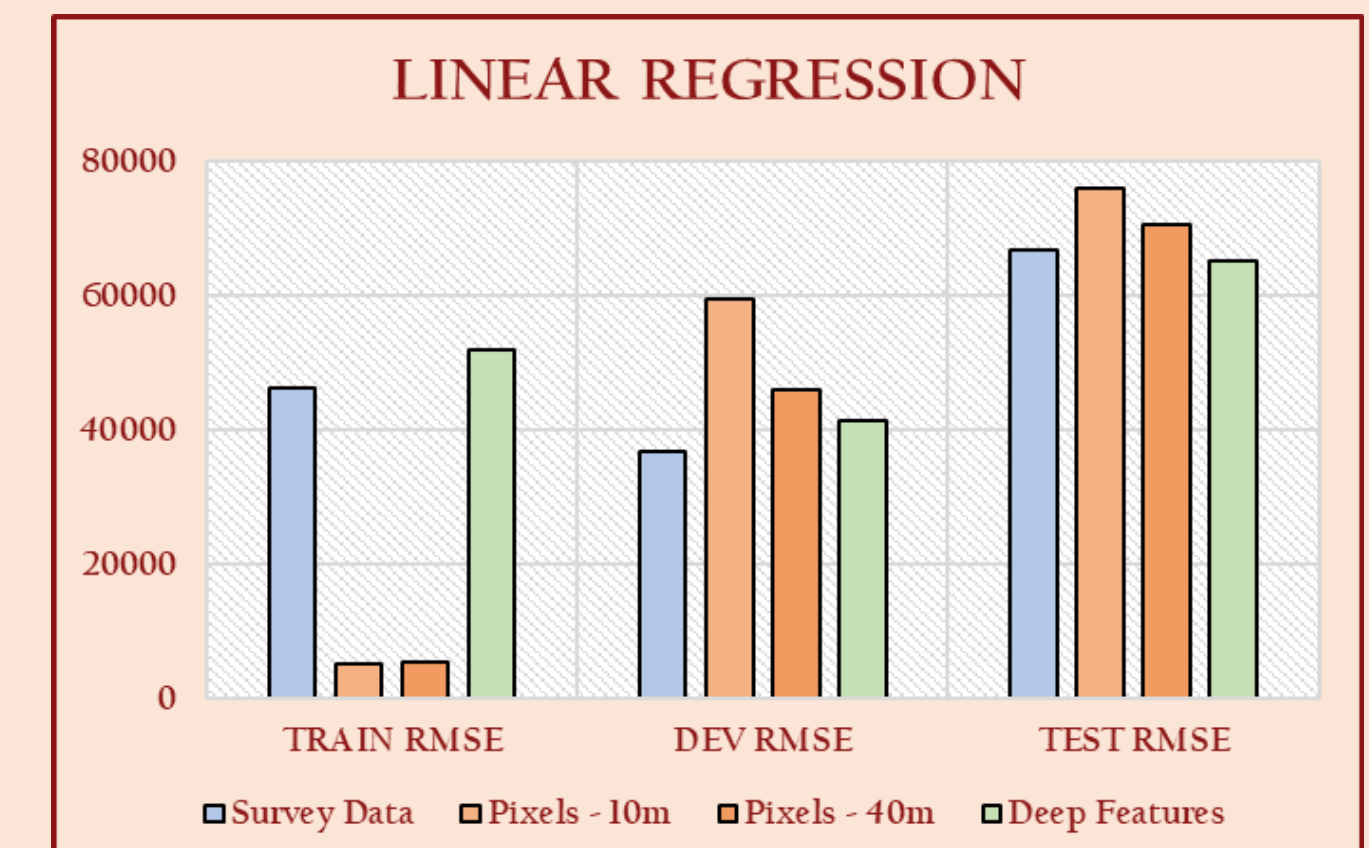
Transfer learning: Deep Features used as Inputs into the Prediction Algorithms.

Final Learning Task: Prediction of rent.

Algorithms: Linear Regression and Multi-Layer Perceptron Regression.



## RESULTS



## CONCLUSIONS AND FUTURE WORK

- Good **relative** performance.
  - Prediction results of image data match those based on survey data in a much more cost-efficient way.
  - \$200K for surveying vs \$500 for flying a drone.
  - 3-6 months vs. 1 week.
- Need to improve **absolute** performance.
  - Extend radius around each house to gather more information.
  - Investigate into further deep-learning network architectures (i.e., NASNet-A).
  - Leverage weak-supervision to enlarge label set without the need to gather additional rent survey data.

## MAIN REFERENCES

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