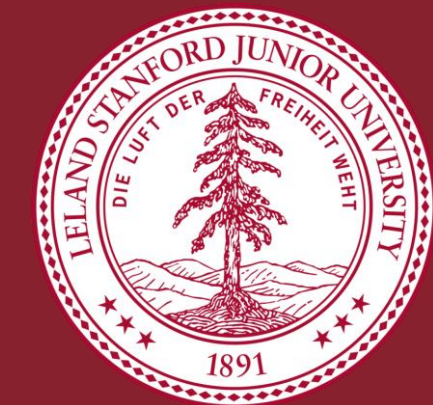# A CNN-RNN Architecture for Multilabel Classification of the Amazon

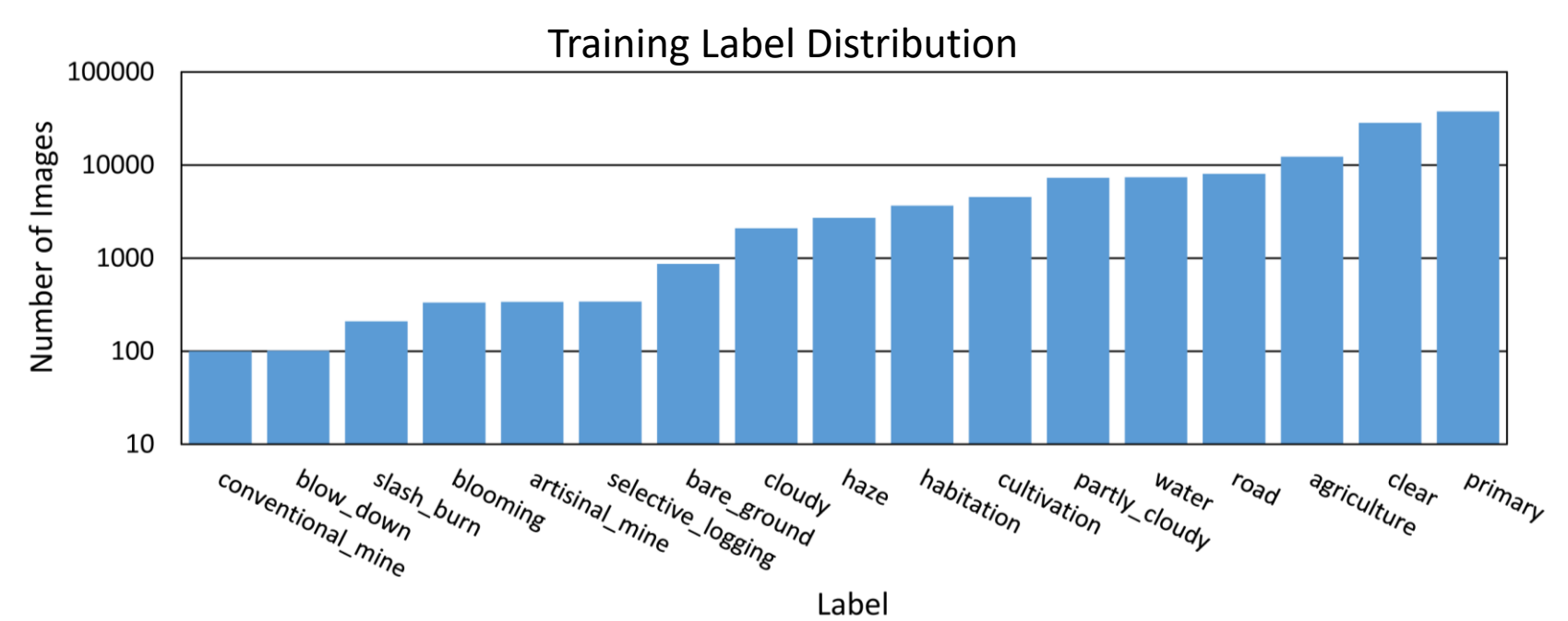Jim Andress and Cristian Zanoci, Stanford University

Motivation

- Deforestation in the Amazon Basin contributes to climate change and reduces biodiversity.
- The size of the Amazon Basin makes human detection of deforestation largely impractical.
- CNN models have proven very successful in classifying satellite images.
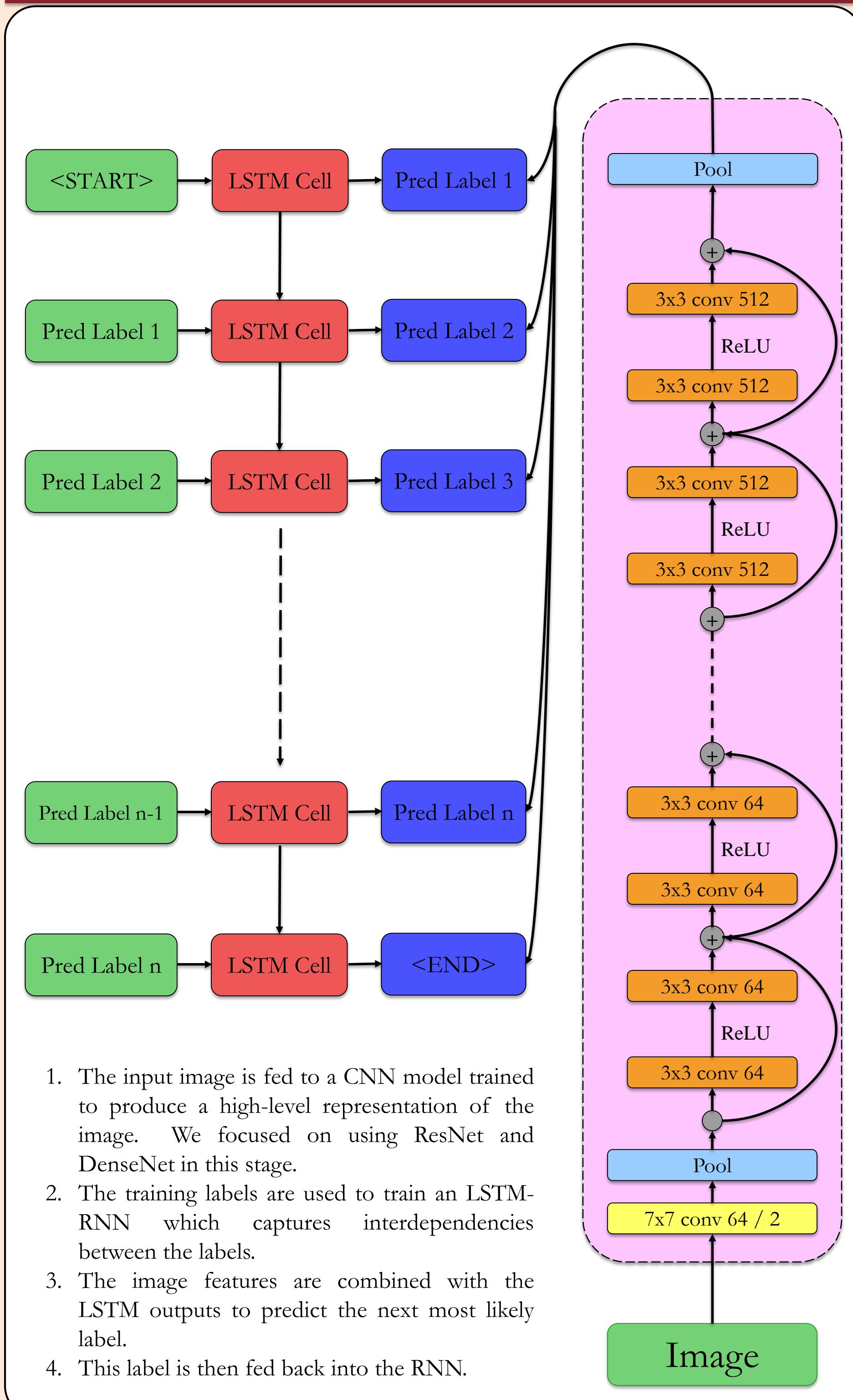
Problem Statement

- Input: An image of a small section of the Amazon

  Output: A set of labels describing the image
- Apply a pre-trained CNN model to produce a high-level representation of the image patch.
- Feed this representation to an RNN and iteratively select labels which correspond to the image features.
- Evaluate using the average F2 score of examples.

Planet's Amazon Image Dataset

- 40,480 training images and 61,192 testing images
- Each image is 256×256 pixels in JPEG format
- Also included 4-channel TIFF images, but data/label mismatches made these unusable.

CNN-RNN Architecture

1. The input image is fed to a CNN model trained to produce a high-level representation of the image. We focused on using ResNet and DenseNet in this stage.
2. The training labels are used to train an LSTM-RNN which captures interdependencies between the labels.
3. The image features are combined with the LSTM outputs to predict the next most likely label.
4. This label is then fed back into the RNN.

Results

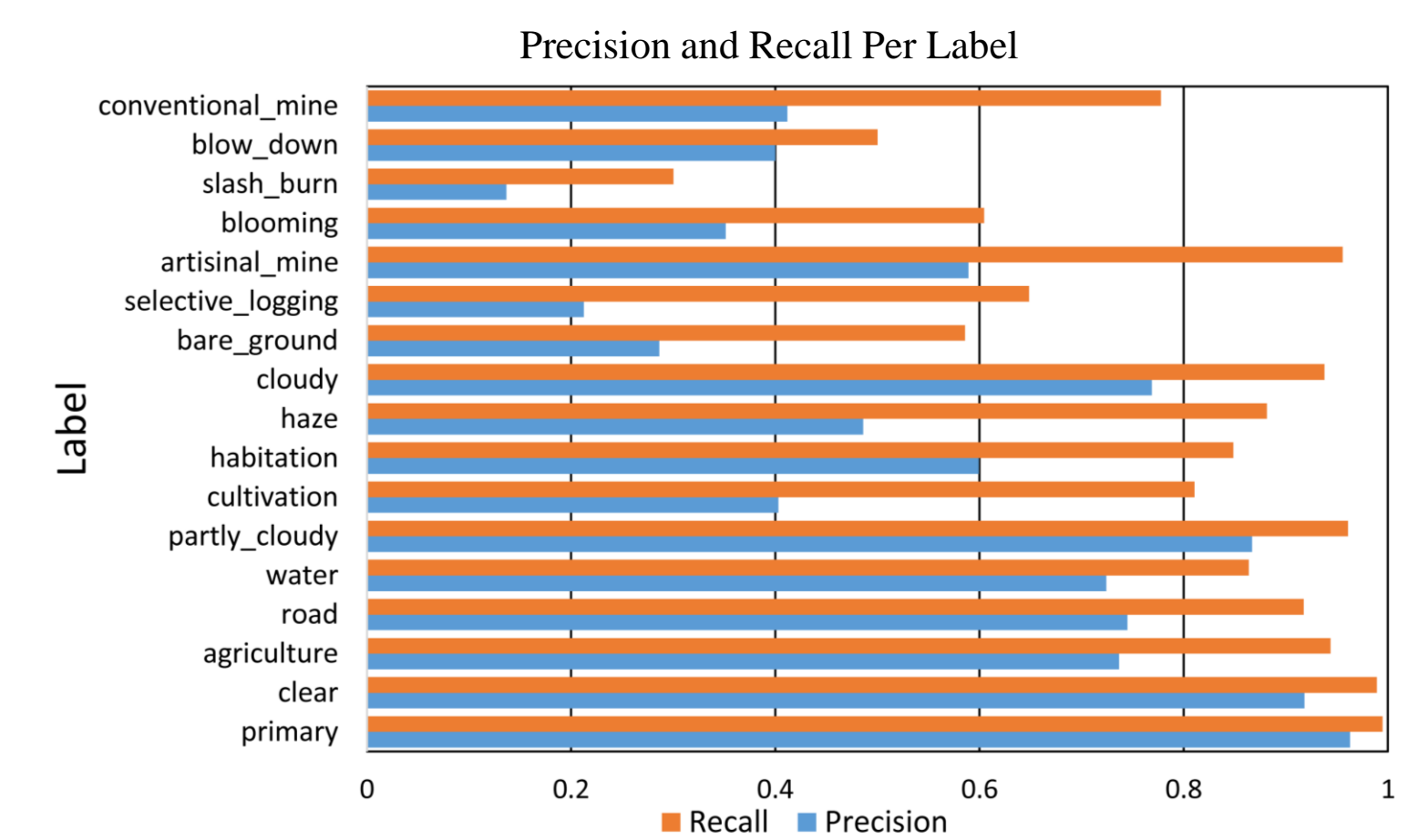| Model	Train F2	Val F2	Test F2
ResNet 18	0.89854	0.91104	0.92229
ResNet 50	0.90589	0.91462	0.92335
DenseNet 169	0.91200	0.92755	0.92276
Ensemble	-	-	0.9255
CNN-RNN	-	0.67569	-
Best on Kaggle	-	-	0.93296

Image Labeling Examples

Predicted: primary, agriculture, clear, cultivation, habitation, road

True: primary, agriculture, clear, cultivation, habitation, road

Predicted: primary, partly_cloudy, water, road

True: primary, partly_cloudy, water

Predicted: primary, road, agriculture, partly_cloudy

True: primary, road, agriculture, partly_cloudy, clear, water

Predicted: primary, clear, road, agriculture, habitation, conventional_mine, bare_ground

True: primary, clear, road, agriculture