An Approach for Automatic and Large Scale Image Forensics

Thamme Gowda[*#], Kyle Hundman [#], and Chris Mattmann [*#]

Presenter: Paul Ramirez [#]

[*] Computer Science Department,
University of Southern California,
Los Angeles, CA, USA

[#] Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA, USA

DARPA DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

NASA Jet Propulsion Laboratory California Institute of Technology

OVERVIEW

- Abstract
- Motivation
- Data
- Image Recognition
- Inception Net
- Integration
- Evaluation
- Conclusion

ABSTRACT

- Applications of deep learning-based image recognition in the DARPA Memex program
- Integration of Tensorflow with Apache Tika for automatic image forensics
- Evaluation of model performance on weapons dataset

MOTIVATION

DARPA Memex:

- Monitor online weapons sale in the United States
- Goal 1: Retrieve ads and relevant multimedia such as images, videos
- Goal 2: Forensics
  - Classify illegal weapons
  - Sale trends
- Goal 3: Discoverable / Searchable

DEFENSE ADVANCED
RESEARCH PROJECTS AGENCY

DATA COLLECTION

- Used web crawlers specialized for retrieving data
  - Crawlers that can login to web sites and run javascript in pages
  - Crawlers that can work with Onion protocol
  - Example: Apache Nutch, Sparkler, Scrapy, … by various teams
- Large repository of web pages and multimedia documents
  - 1.4 M images from weapons domain

IMAGE RECOGNITION TASK

- Image Recognition: Detect real word entities in the digital images
- ImageNet dataset:
  - Large visual dataset of annotated images
- ImageNet Large Scale Visual Recognition Challenge (ILSVRC)
  - Annual competition organized by Stanford and Princeton Universities
  - Challenge: How accurately can your model identify 1000 classes
  - From 2010 to Now
  - Since 2012, Deep ConvNets ruled the competition
  - Goto place to see state-of-the-art models for image recognition

INCEPTION NET

- Developed by Google Research Team
  - Sergey et al,2015 - Originally GoogleNet, winner of ILSVRC 2014
  - Code named Inception, multiple version V1, V2, V3, V4,..
- Google open sourced Tensorflow with Inception-V3 and its model trained on ImageNet dataset
- Inception-V3 is optimized to run with less memory and fewer CPU cycles (like Android devices)
- We have used Inception-V3 for our forensics

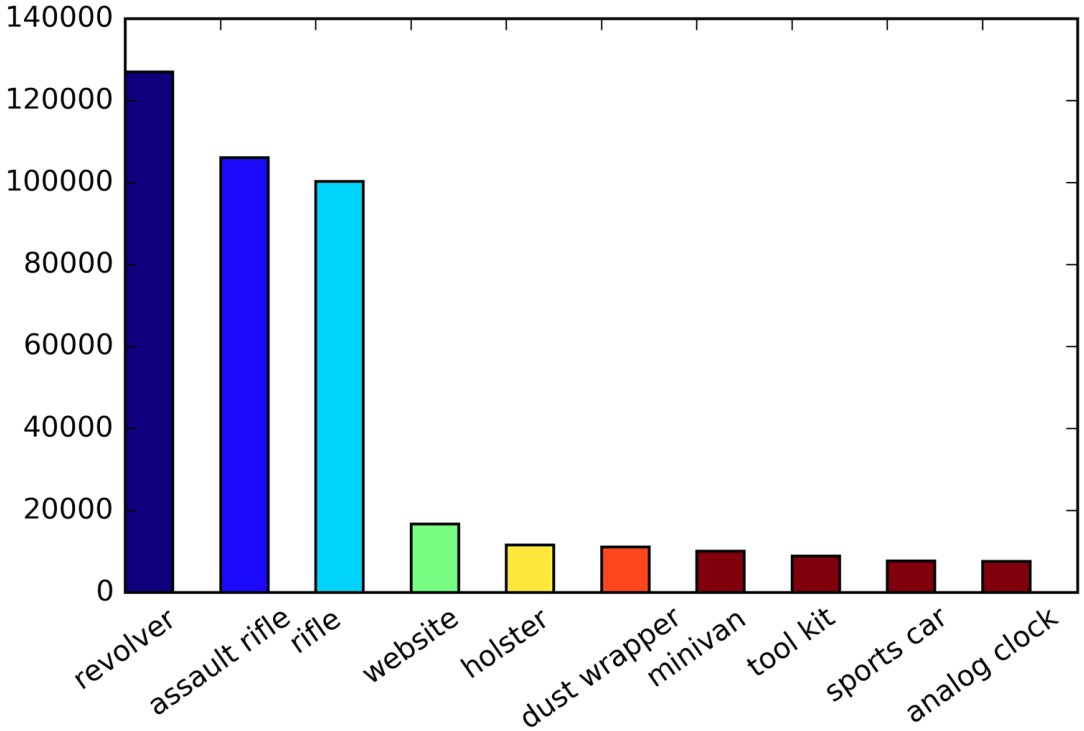
SOFTWARE STACK

- Apache Tika - universal parser for parsing files over a thousand file types
  - Primarily written in Java; available for free via Apache License
  - Meta data analysis
  - Semantic analysis - detect names of people, locations etc in text
  - And more - OCR in images
  - One of the key technology for content analysis in DARPA Memex
  - Had been useful for others too - heard of Panama Papers?
- Tensorflow
  - Written in C++ with Python bindings; available free via Apache License
  - Developed by google and now one of the popular deep learning frameworks

INTEGRATION METHODS

- Challenge:
  - Make use of C++/Python code from a Java Client
- Techniques
  - Command Line Invocation (CLI)
  - Java Native Interface (JNI)
  - gRPC Remote Procedure Call (gRPC)
  - REpresentation State Transfer (REST) API
- REST API integration was the best among the above four

RESULTS



Labeled the 1.4 million images in Memex Weapons Dataset

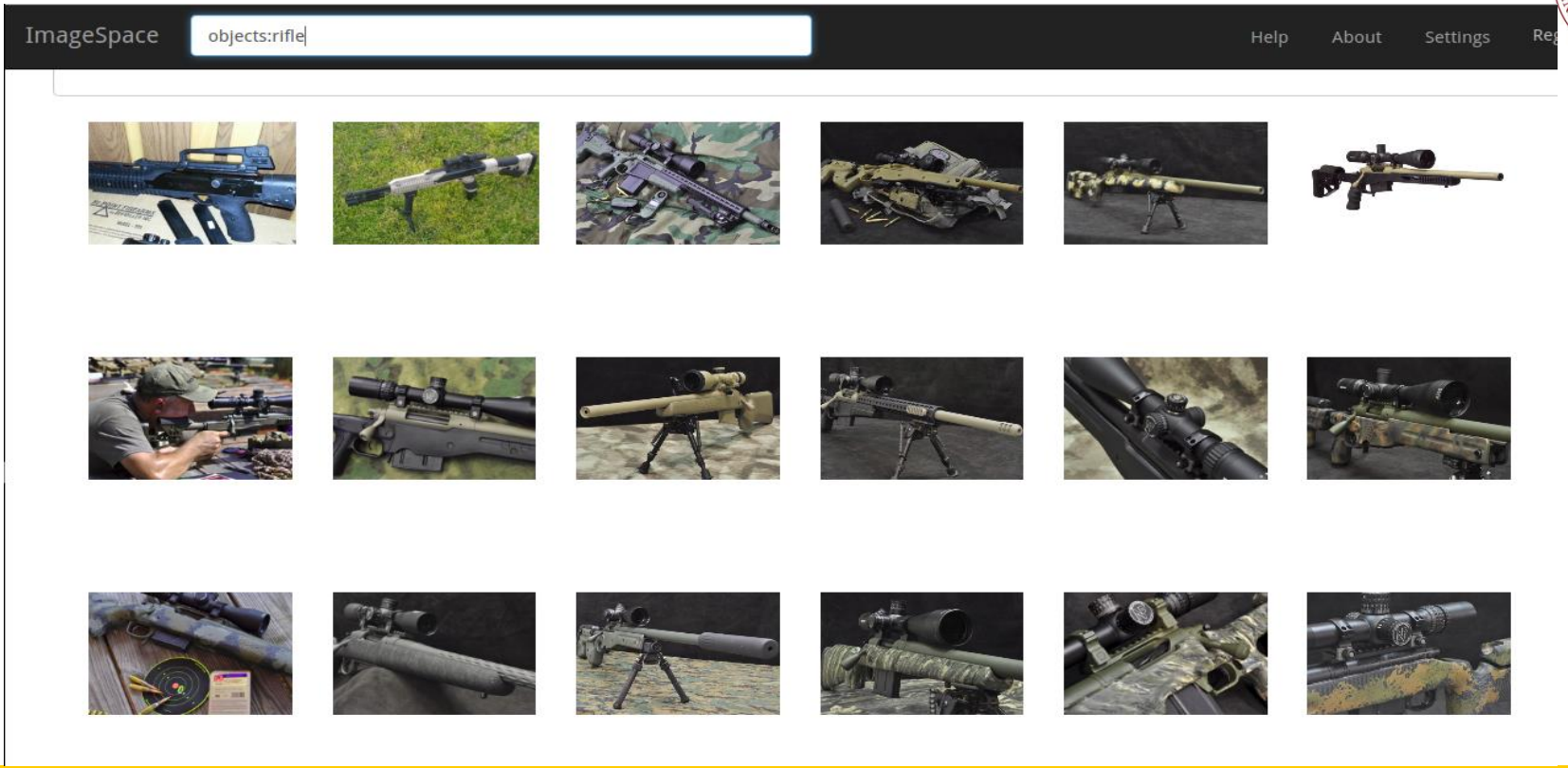
1000 target classes in training data (ImageNet)

HANDLING THE SCALE

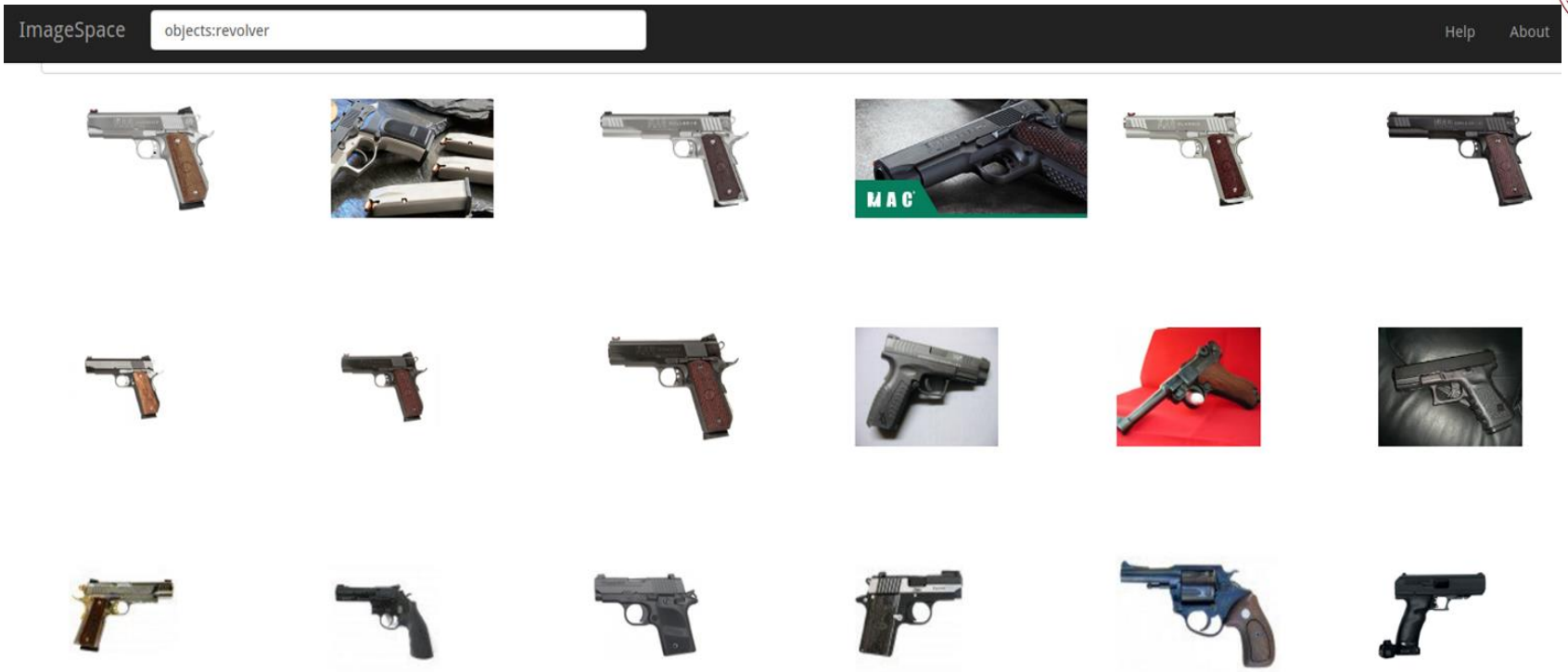
- 1.4 million images in the dataset
- REST integration took 36 hours to run on 32 Core CPUs, no GPUs used
- TensorFlow automatically parallelized the load on all CPU cores in a single node
- Wiki https://wiki.apache.org/tika/TikaAndVision

- **Recent work:** We have hadoop/spark distributable framework powered by Deeplearning4j
  - https://wiki.apache.org/tika/TikaAndVisionDL4J
  - https://github.com/thammegowda/tika-dl4j-spark-imgrec

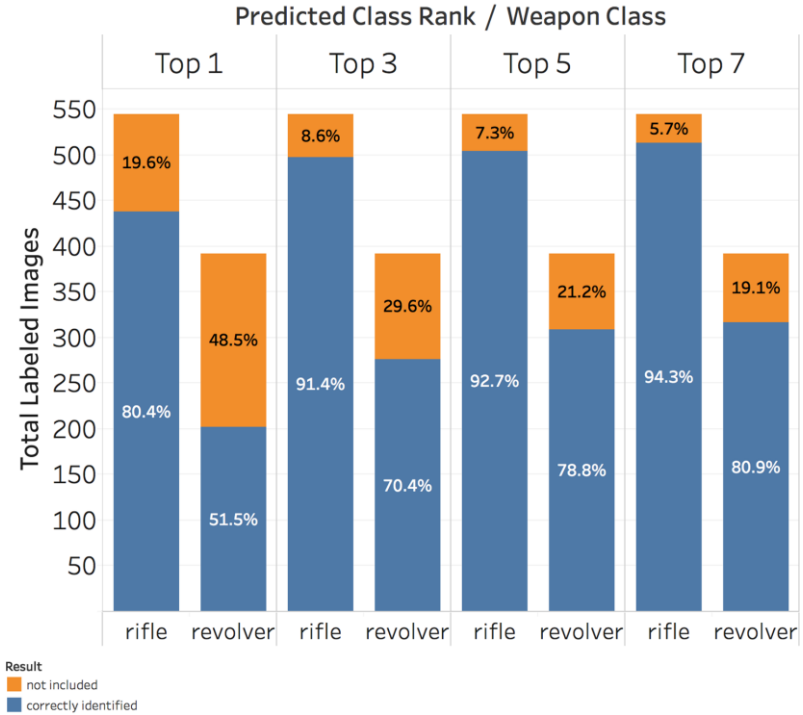
RIFLES



REVOLVERS



EVALUATION



Our evaluation dataset:

- Consists of gun images
- Law enforcement officers manually labelled them

Observations:

- Some Rifles mislabeled based on surrounding objects - small size
- Top - 5 measure is a reasonable measure

CONCLUSION

- We have made image recognition easy for Apache Tika users
- We have tested that Inception-V3 model was successful in detecting weapon images
- Image labels helped to build a better web page classifier for Memex

ACKNOWLEDGEMENT:

This effort was supported in part by JPL, managed by the California Institute of Technology on behalf of NASA, and additionally in part by the DARPA Memex/XDATA/D3M programs and NSF award numbers ICER-1639753, PLR-1348450 and PLR-144562 funded a portion of the work

THANKS