

DISTRACTED DRIVER DETECTION

Using Convolutional Neural Networks
and Transfer Learning



PROBLEM STATEMENT

Given a dataset of images, classify each driver's behavior.



Are they driving safely?

Talking on the phone?

Drinking from a cup?

MOTIVATION

In the U.S alone, **425,000** people are injured, and **3,000** are killed as a result of distracted driving according to the Centers for Disease Control and Prevention (CDC) in 2015.

These numbers only increase as the reliance on technology increases.



RESEARCH NOTE

U.S. Department of Transportation March 2017



U.S. Department
of Transportation
National Highway
Traffic Safety
Administration

TRAFFIC SAFETY FACTS Research Note



DOT HS 812 381

Summary of Statistical Findings

March 2017

Distracted Driving 2015

The National Highway Traffic Safety Administration (NHTSA) works to reduce the occurrence of distracted driving and raise awareness of its dangers. This risky behavior poses a danger to vehicle occupants as well as pedestrians and bicyclists. Driver distraction is a specific type of driver inattention. Distraction occurs when drivers divert their attention from the driving task to focus on some other activity. Oftentimes, discussions regarding distracted driving center around cell phone use and texting, but distracted driving also includes other activities such as eating, talking to other passengers, or adjusting the radio or climate controls. A distraction-affected crash is any crash in which a driver was identified as distracted at the time of the crash.

- Ten percent of fatal crashes, 15 percent of injury crashes, and 14 percent of all police-reported motor vehicle traffic crashes in 2015 were reported as distraction-affected crashes.
- In 2015, there were 3,477 people killed and an estimated additional 391,000 injured in motor vehicle crashes involving distracted drivers.
- Nine percent of all drivers 15 to 19 years old involved in fatal crashes were reported as distracted at the time of the

As defined in the *Overview of the National Highway Traffic Safety Administration's Driver Distraction Program* (Report No. DOT HS 811 299), distraction is a specific type of inattention that occurs when drivers divert their attention from the driving task to focus on some other activity instead. The document describes distraction as a subset of inattention (which also includes fatigue, and physical and emotional conditions of the driver). However, while NHTSA may define the terms in this manner, inattention and distraction are often used interchangeably or simultaneously in other material, including police crash reports. It is important that NHTSA and NHTSA's data users be aware of these differences in definitions. It is also important to acknowledge the inherent limitations in the data collection for distraction-affected crashes and the resulting injuries and fatalities. The appendix of this document contains a table that describes the coding for distraction-affected crashes for FARS and GES as well as a discussion regarding limitations in the distracted driving data.

Data

Fatalities in Distraction-Affected Crashes

In 2015, there were a total of 32,166 fatal crashes in the United

DATA

DISTRACTED DRIVER DETECTION COMPETITION



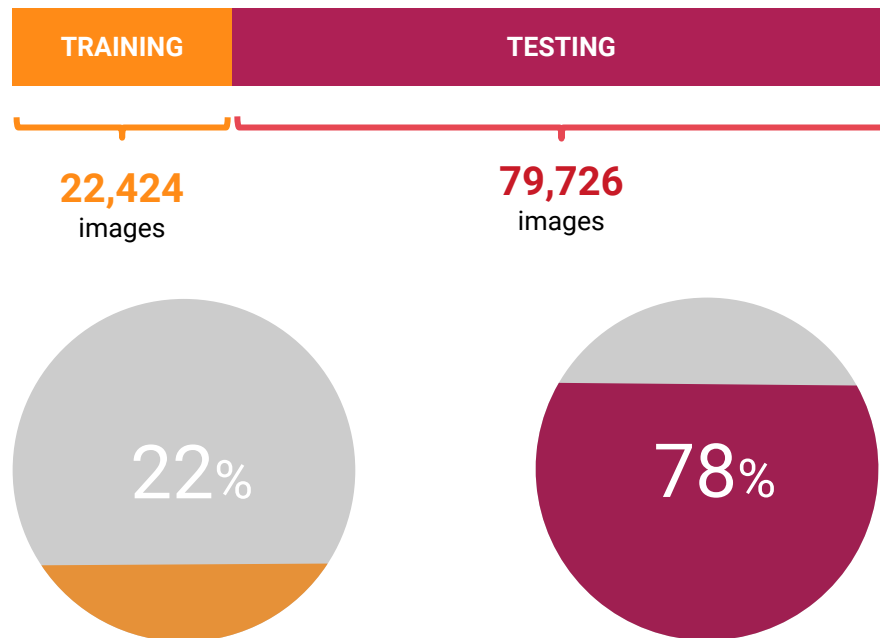
Platform for data science
competitions and tutorials



Provide a dataset of labeled and
unlabeled images of
(non)distracted drivers.

DATA

CLASS	DESCRIPTION
c0	Safe driving.
c1	Texting (right hand).
c2	Talking on the phone (right hand).
c3	Texting (left hand).
c4	Talking on the phone (left hand).
c5	Operating the radio.
c6	Drinking.
c7	Reaching behind.
c8	Hair and makeup.
c9	Talking to passenger(s).



DATA

TESTING SET

	A	B	C	D
1	img_c0	c1	c2	
2	img_1.jpg	0.1	0.1	0.1
3	img_10.jpg	0.1	0.1	0.1
4	img_100.jpg	0.1	0.1	0.1
5	img_1000.jpg	0.1	0.1	0.1
6	img_100000.	0.1	0.1	0.1
7	img_100001.	0.1	0.1	0.1
8	img_100002.	0.1	0.1	0.1
9	img_100003.	0.1	0.1	0.1
10	img_100004.	0.1	0.1	0.1
11	img_100005.	0.1	0.1	0.1
12	img_100007.	0.1	0.1	0.1
13	img_100008.	0.1	0.1	0.1
14	img_100009.	0.1	0.1	0.1
15	img_10001.ji	0.1	0.1	0.1
16	img_100010.	0.1	0.1	0.1
17	img_100011.	0.1	0.1	0.1
18	img_100012.	0.1	0.1	0.1
19	img_100013.	0.1	0.1	0.1

kaggle™

$$\text{logloss} = -\frac{1}{N} \sum_{i=1}^N \sum_{j=1}^M y_{ij} \log(p_{ij}),$$

Multi-class logarithmic loss

In the money Gold Silver Bronze					
#	△ pub	Team Name	Kernel	Team Members	Score @
1	▲ 1	jacobkie			0.08739
2	▲ 2	Z_B_C			0.09057
3	—	BRAZIL POWER			0.09058
4	▼ 3	MakeAmericaGreatAgain			0.10065

Run the model on
the test data

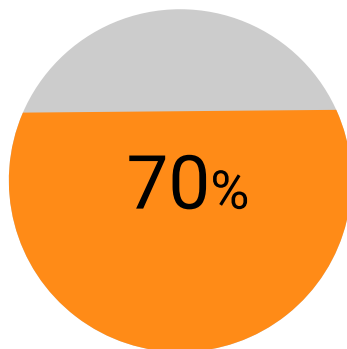
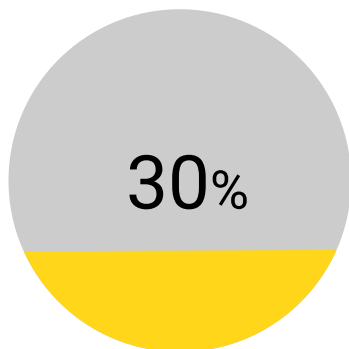
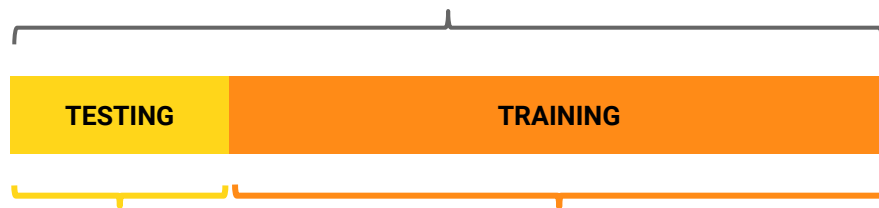
Submit Predictions to
Kaggle

Obtain Score and a ranking on the
leaderboards

DATA

TRAINING SET

Labeled data



ACCURACY %

DATA

DRIVER IMAGE EXAMPLES



Safe driving
(c0)



Texting with right hand
(c1)



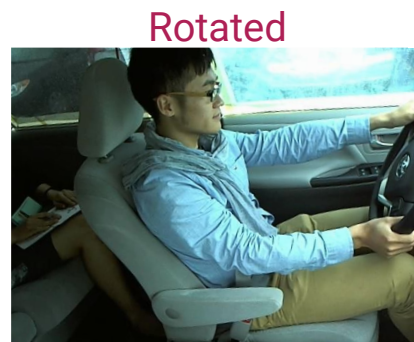
Doing hair & makeup
(c8)

DATA MANIPULATION

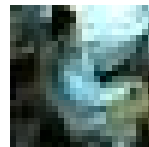
AUGMENTATION



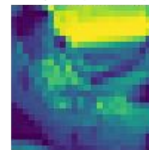
(640 x 480)



DATA CLEANING



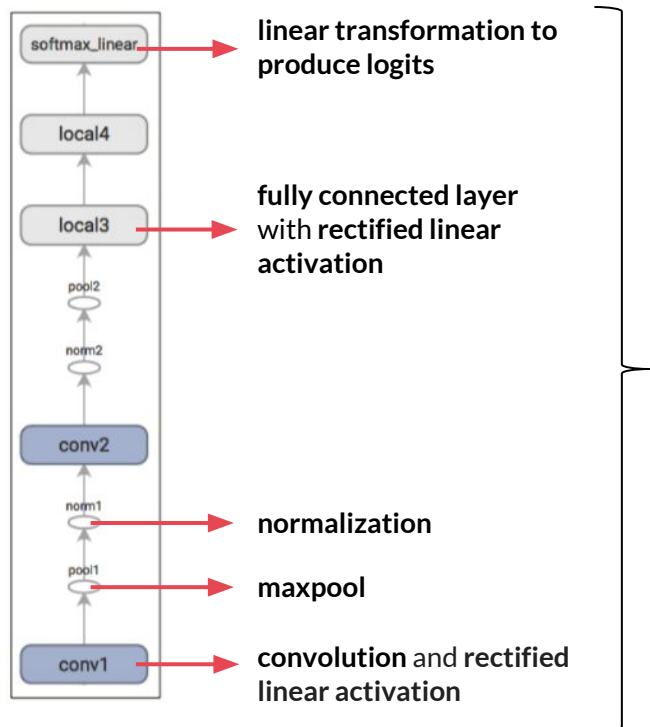
(24 x 24)



greyscale

IMPLEMENTATION

CONVOLUTIONAL NEURAL NETWORK



Alternating convolutions & nonlinearities

Softmax Classifier

86% accuracy on CIFAR-10, with few hours of training (GPU)

DEMO

CONVOLUTIONAL NEURAL NETWORK



CHALLENGES

- **HARDWARE**

- Running on laptop CPU is not practical for training model
- Need GPU Hardware
- None immediately available at our disposal

- **CLOUD COMPUTING SERVICES**

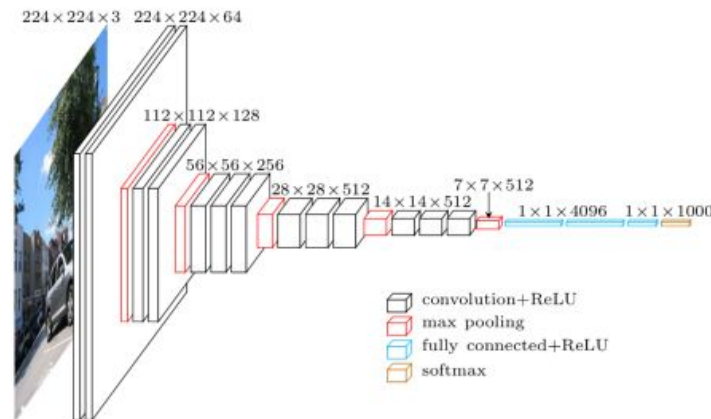
- Digital Ocean
- Google Cloud Platform
- GPUs on the cloud are very expensive



TRANSFER LEARNING

DEEP CONVOLUTIONAL NETWORK VGG16

- 16-layer Convolutional Network
- 3 fully connected Layers
- 92.7% top-5 test accuracy in ImageNet Challenge
- Pre-trained weights available
- Use to reduce training time
- Increase accuracy



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