

Machine Learning de Google

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KSchool / Septiembre 2019

Agenda

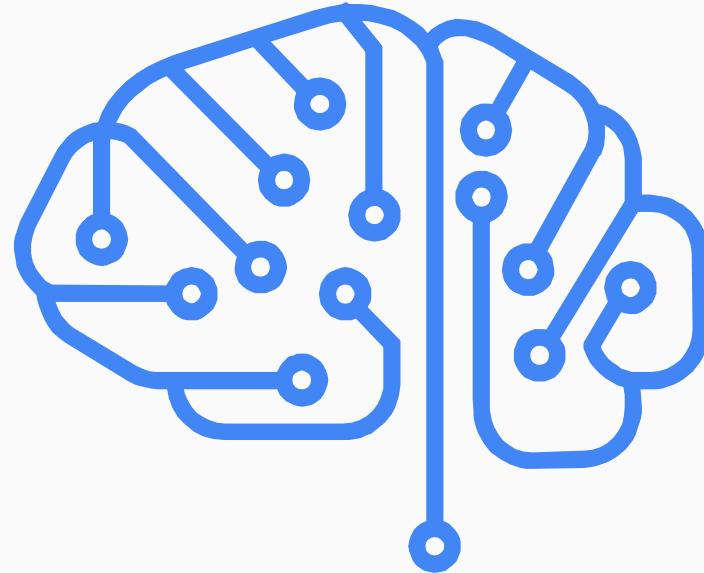
- From the Artificial Intelligence to Machine Learning
- Cognitive Computing ML APIs
- Tensorflow
- Cloud ML

From the Artificial Intelligence to Machine Learning



Inteligencia Artificial es
la ciencia de hacer las
cosas inteligentes

Machine learning
Es una de las técnicas
para desarrollar la IA.



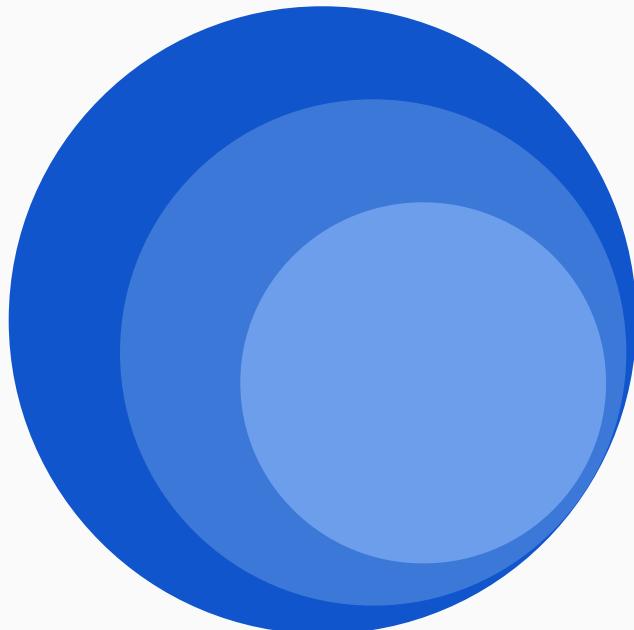


Inteligencia Artificial permite a una máquina **imitar** las funciones cognitivas que los humanos asocian con otras mentes humanas, como puede ser **aprender** o **resolver problemas**.





- **Sistemas que piensan como humanos** (automatizan procesos del pensamiento humano, como la toma de decisiones, resolución de problemas y aprendizaje). Ejemplo Redes Neuronales artificiales.
- **Sistemas que actúan como humanos** (imitan el comportamiento humano). Ejemplo Robots.
- **Sistemas que piensan racionalmente** (tratan de emular el pensamiento lógico racional del ser humano, el estudio de los datos les permite percibir, razonar y actuar). Ejemplo Sistemas Expertos.
- **Sistemas que actúan racionalmente** (emulan de forma racional el comportamiento humano). Ejemplo Agentes Inteligentes (Self driving car)



Inteligencia Artificial

Cosas inteligentes

Machine intelligence

Máquinas inteligentes

Machine learning

Máquinas que aprenden para ser las inteligentes

Machine Learning

Machine Learning es un campo de la ciencia informática que permite a los ordenadores aprender sin haber sido programados explícitamente para ello.

Explora la generación de algoritmos que pueden aprender y hacer predicciones sobre datos.

1. Obtiene datos (para entrenar el modelo)
2. Obtiene patrones de esos datos
3. Clasifica nuevos datos que no ha visto antes basado en el punto 2

Machine Learning - tipos de aprendizaje

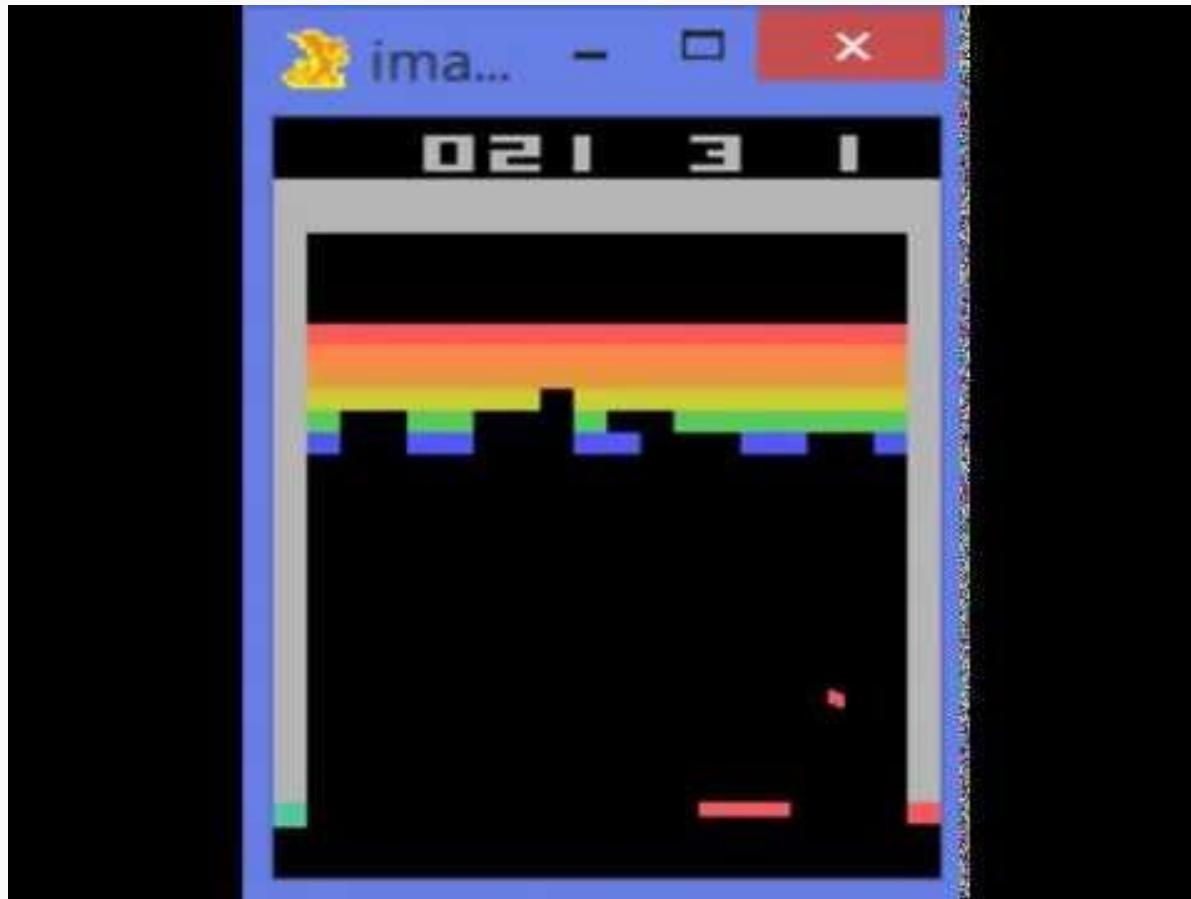
En función del tipo de señal o retroalimentación al sistema:

- **Aprendizaje supervisado (Supervised Learning):** set de entrenamiento etiquetado.
 - Semi-supervised learning. (set de entrenamiento incompleto).
 - Active learning. (interactúa con el usuario para etiquetar).
 - Reinforcement learning. (set de entrenamiento basado en recompensa y castigo).
- **Aprendizaje no supervisado (Unsupervised Learning):** no se añaden etiquetas al sistema. El sistema buscará patrones en los datos.

Machine Learning - aprendizaje orientado al resultado

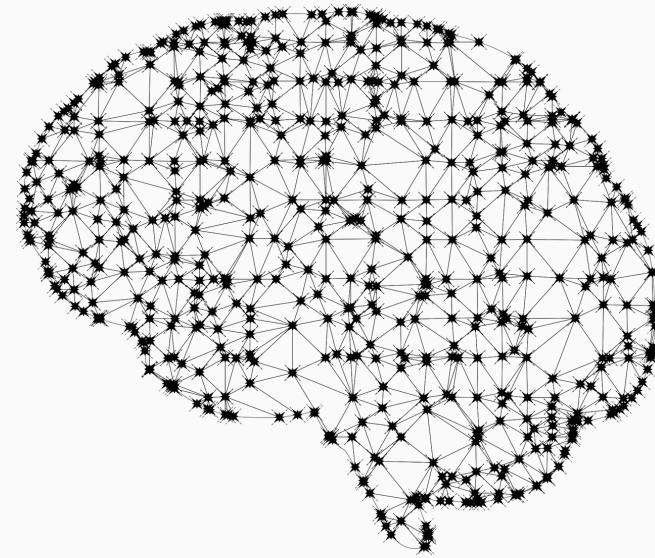
- **Clasificación:** el input se divide en 2 o más clases, y se produce un modelo que aplica una o varias etiquetas a los datos de estudio. Sobre datos discretos. En general es un aprendizaje supervisado.
- **Regresión:** se busca clasificar datos continuos utilizando una función matemática. Aprendizaje supervisado.
- **Clustering:** los datos de entrada se agregan en grupos no conocidos a priori, utilizando algún algoritmo de clasificación. Aprendizaje no supervisado.
- **Estimación de densidad:** mapea la distribución de los datos en un espacio. No supervisado.
- **Reducción de dimensionalidad:** simplifica los inputs mapeándolos en grupos más grandes. El modelado de topics sería un ejemplo.

Machine Learning - Breakout sample (Reinforcement learning)



Machine Learning - algoritmos

- Decision tree learning
- Association rule learning
- **Artificial neural networks (ANN)**
- Deep learning
- Inductive logic programming (ILP)
- Support vector machines (SVM)
- Clustering
- Bayesian networks
- Reinforcement learning
- Representation learning
- Similarity and metric learning
- Sparse dictionary learning
- Genetic algorithms
- Rule-based machine learning
- Learning classifier systems (LCS)
-



Artificial neural networks (ANN)

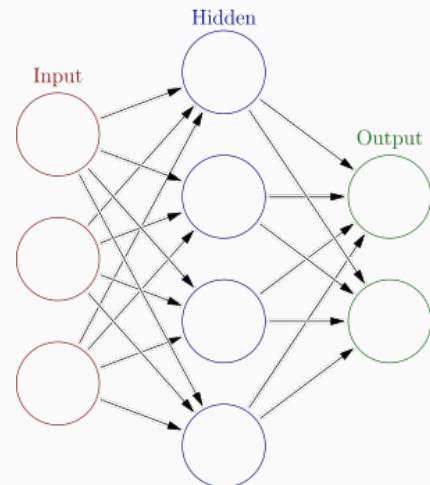


Sistemas computacionales inspirados en las neuronas que componen el cerebro humano.

Son capaces de aprender, mejorando el rendimiento con el tiempo (y los datos), basados en ejemplos, sin programación específica.

Generan un modelo con su propio set de características relevantes sobre los datos de entrenamiento.

Una ANN es una colección de nodos conectados (Neurona Artificial). Cada conexión transmite señal de una a otra.

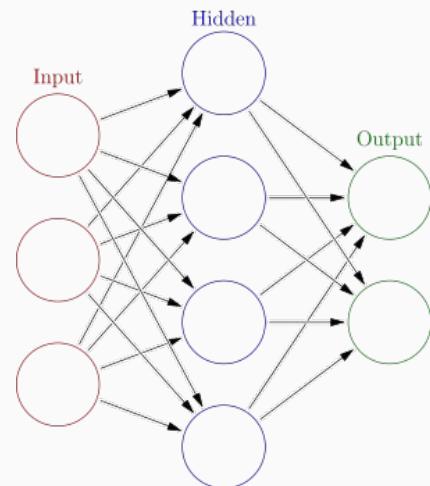


Machine Learning - ANN

La señal entre neuronas es un número real (0-1 en Tensorflow) y la salida de cada neurona se calcula con una función no lineal como agregado de sus inputs.

Las neuronas tienen asignado un peso para ajustar el proceso de aprendizaje en el grafo completo.

Las neuronas se organizan en capas (hidden layers).



Machine Learning - Deep Learning



El **Aprendizaje Profundo**, *deep structured learning* o *hierarchical learning*, es parte de un grupo de métodos de ML basados en el learning data representations.

Relacionados con los sistemas nerviosos biológicos, buscan definir las relaciones entre varios estímulos y las respuestas neuronales asociadas en el cerebro.

Ejemplos de DL son las **Deep Neural Networks (DNN)**, **Deep Belief Networks** o **Recurrent Neural Networks (RNN)**.

Utilizan múltiples capas de procesado no lineal para la extracción de elementos y su procesado.

Aprenden de manera supervisada (ej. clasificación) o no supervisada (ej. reconocimiento de patrones).

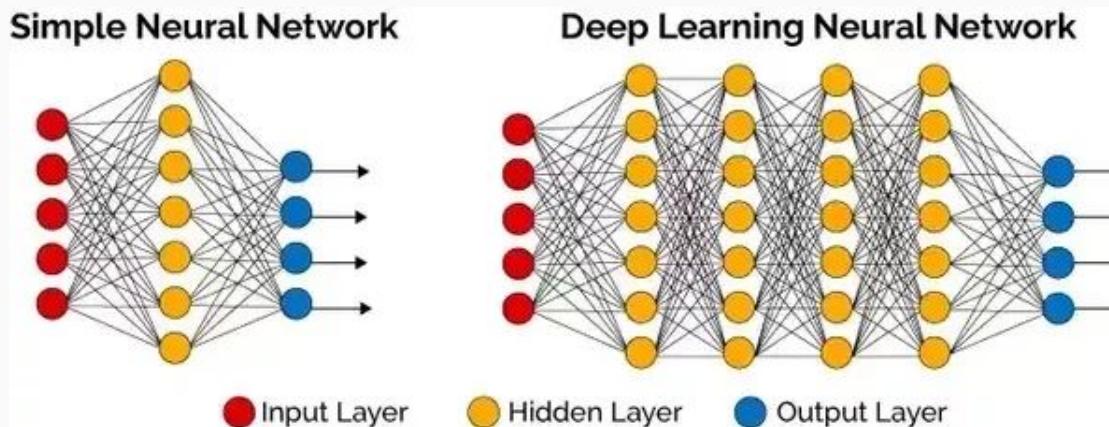
Machine Learning - ANN vs DNN vs RNN



ANN: Red neuronal, genérico. Puede ser simple o recurrente.

DNN: Red neuronal profunda, con n capas.

RNN: Red neuronal recurrente, con retroalimentación en la red.



Neural Network - Almost complete diagram

A mostly complete chart of

Neural Networks

©2016 Fjodor van Veen - asimovinstitute.org

○ Backfed Input Cell

○ Input Cell

△ Noisy Input Cell

● Hidden Cell

○ Probabilistic Hidden Cell

△ Spiking Hidden Cell

● Output Cell

○ Match Input Output Cell

● Recurrent Cell

○ Memory Cell

△ Different Memory Cell

● Kernel

○ Convolution or Pool

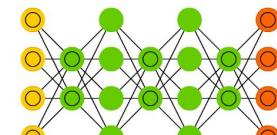
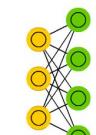
Markov Chain (MC)

Hopfield Network (HN)

Boltzmann Machine (BM)

Restricted BM (RBM)

Deep Belief Network (DBN)



Perceptron (P)

Feed Forward (FF)

Radial Basis Network (RBF)

Recurrent Neural Network (RNN)

Long / Short Term Memory (LSTM)

Gated Recurrent Unit (GRU)

Auto Encoder (AE)

Variational AE (VAE)

Denoising AE (DAE)

Sparse AE (SAE)

Deep Feed Forward (DFF)

Deep Convolutional Network (DCN)

Deconvolutional Network (DN)

Deep Convolutional Inverse Graphics Network (DCIGN)

Generative Adversarial Network (GAN)

Liquid State Machine (LSM)

Extreme Learning Machine (ELM)

Echo State Network (ESN)

Deep Residual Network (DRN)

Kohonen Network (KN)

Support Vector Machine (SVM)

Neural Turing Machine (NTM)

Una manera diferente de hacer las cosas

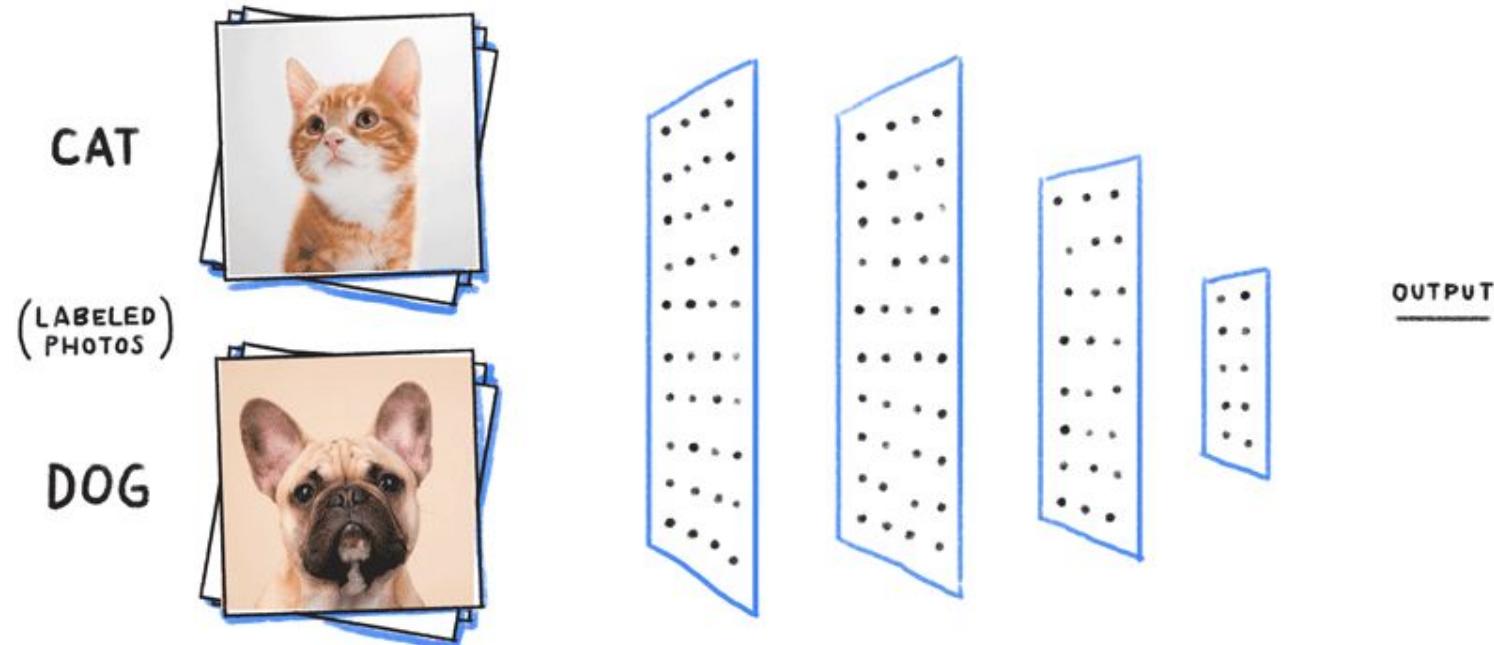
Escribir un programa de ordenador que sigue **reglas explícitas**

```
if email contains V!agrå  
    then mark is-spam;  
  
if email contains ...  
  
if email contains ...
```

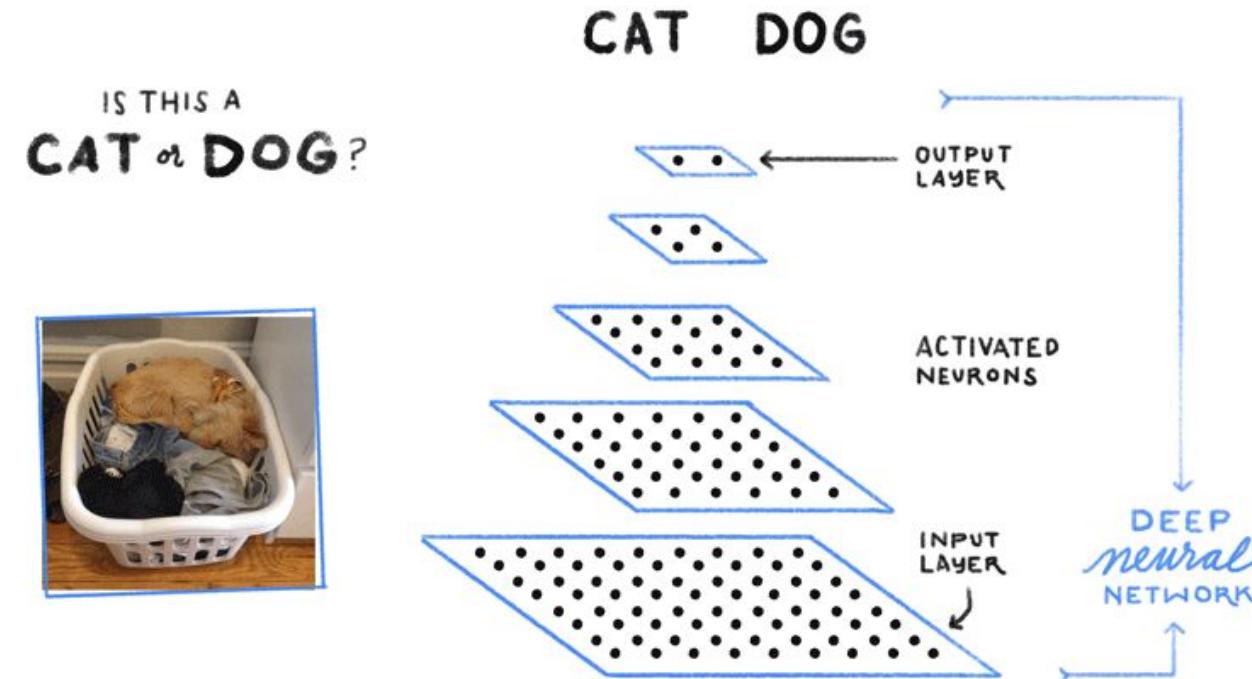
Escribir un programa de ordenador que **aprende de ejemplos**

```
try to classify some emails;  
change self to reduce errors;  
repeat;
```

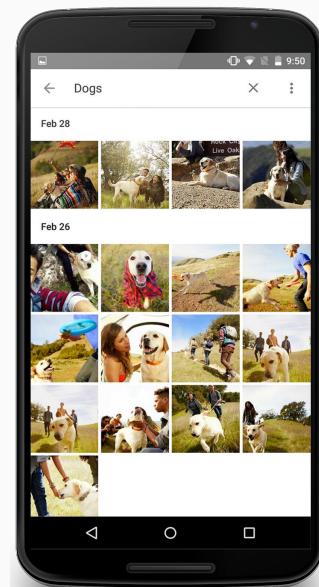
Deep Neural Networks Paso 1: Entrenamiento



Deep Neural Networks Paso 2: testing



Deep Neural Networks Paso 3: productivizar



Machine Learning - TensorFlow Playground

DATA

Which dataset do you want to use?



Ratio of training to test data: 50%

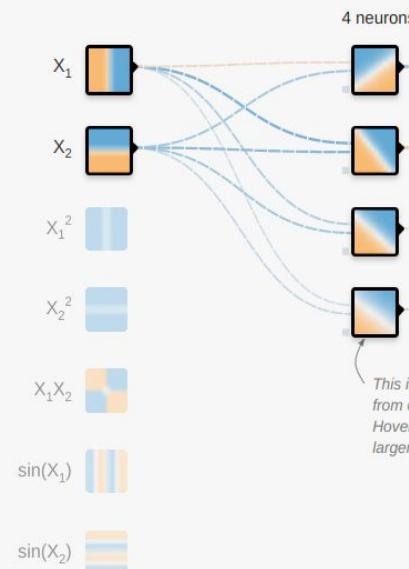
Noise: 0

Batch size: 10

REGENERATE

FEATURES

Which properties do you want to feed in?



+

-

2 HIDDEN LAYERS

+

-

4 neurons

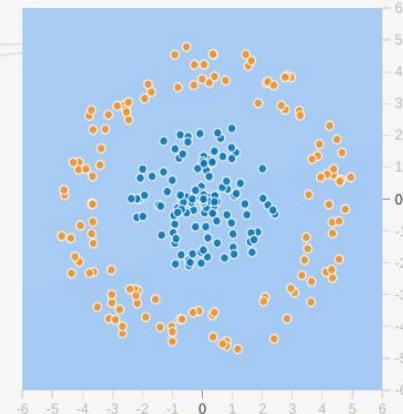
2 neurons

The outputs are mixed with varying weights, shown by the thickness of the lines.

OUTPUT

Test loss 0.504

Training loss 0.507



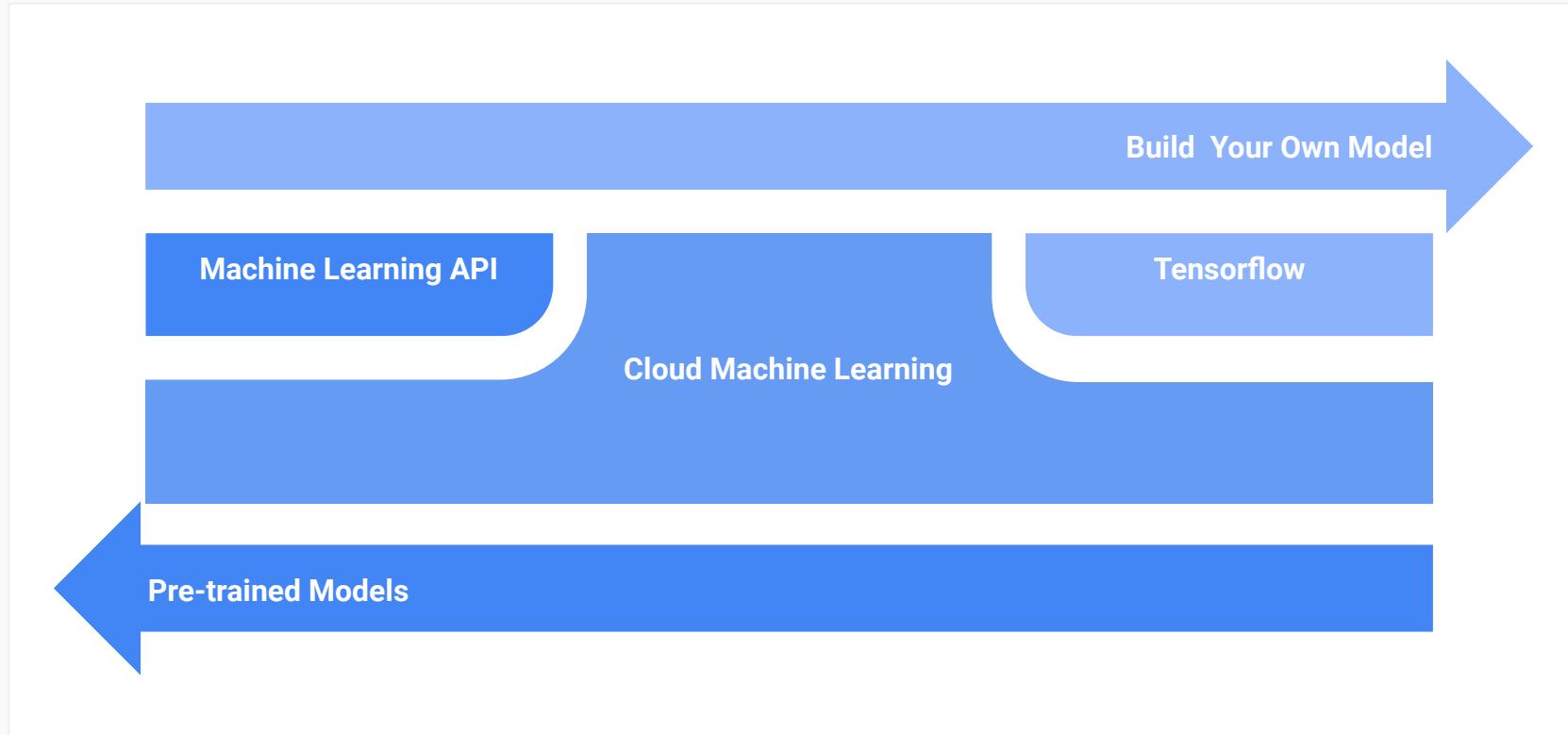
Colors shows data, neuron and weight values.



Show test data

Discretize output

Machine Learning - Google offering today



Machine Learning - AI Experiments

[AI Experiments ▾](#)

[About](#)

[News & Events](#)

[Search](#)

[SUBMIT EXPERIMENT](#)

Explore machine learning in simple, hands-on ways.

[Read more](#)

FEATURED EXPERIMENTS

A person's hand is shown interacting with a laptop screen displaying the Teachable Machine web application. The screen shows various machine learning models and QR codes.

TEACHABLE MACHINE

by Google Creative Lab

A hand is shown drawing a bicycle on a tablet screen using the Quick, Draw! app. The text "Oh I know, it's bike!" is displayed on the screen.

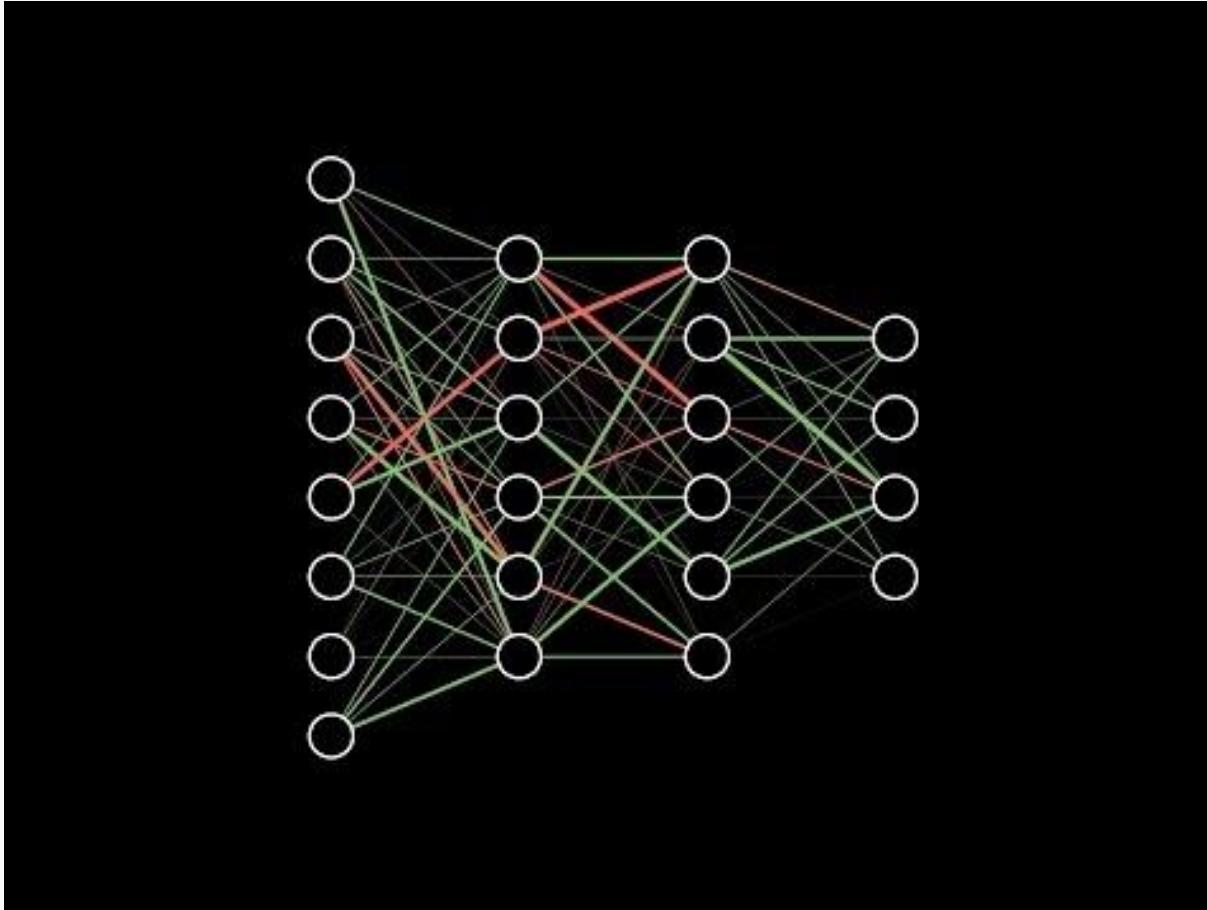
QUICK, DRAW!

by Google Creative Lab

Machine Learning - 7 Steps of ML



Machine Learning - What is a Neural Network ?



Machine Learning - How Convolutional Networks work

Putting it all together

A set of pixels becomes a set of votes.



92

.51

Cognitive Computing ML APIs





Cloud Vision API

Insight from images with our powerful
Cloud Vision API

Cloud Vision API

Faces

Faces, facial landmarks, emotions



Label

Detect entities from furniture to transportation



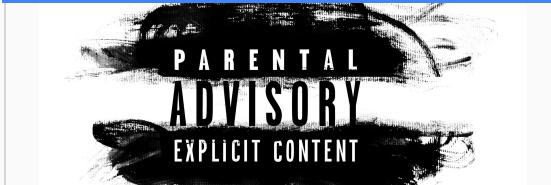
Logos

Identify product logos



Safe Search

Detect explicit content - adult, violent, medical and spoof



OCR

Read and extract text, with support for > 10 languages



Landmarks & Image Properties

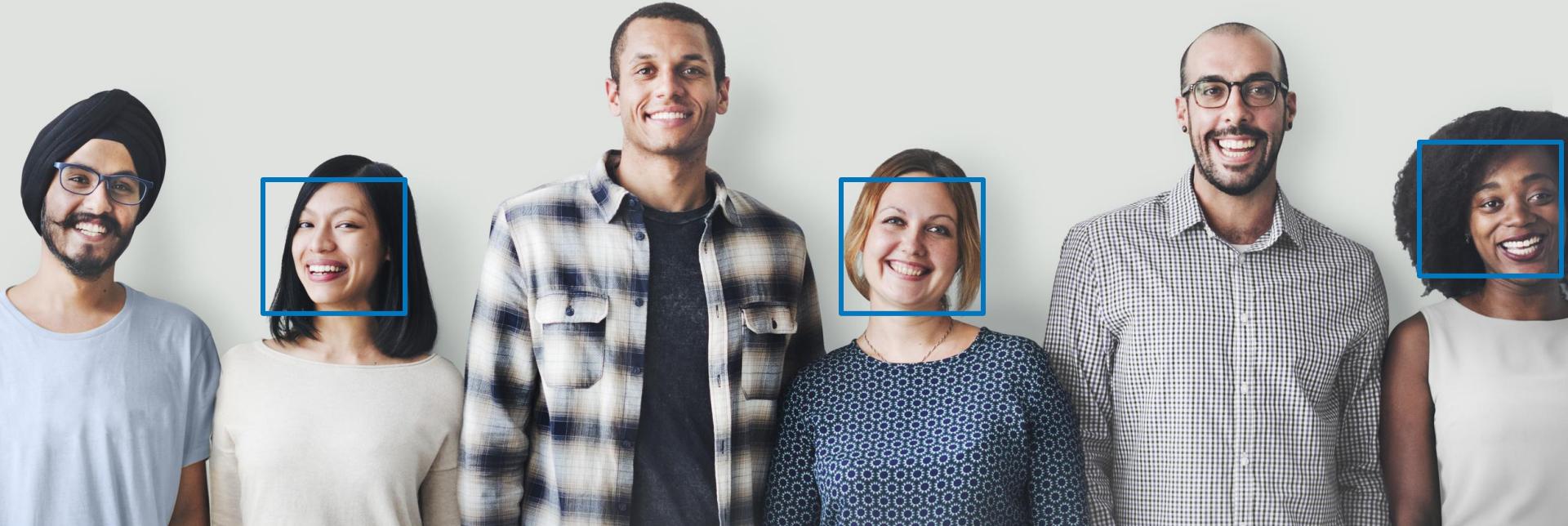
Detect landmarks & dominant color of image



Cloud Vision API

Call API from anywhere, with support for embeddable images, and Google Cloud storage

Vision API Demo





Cloud Speech API

Speech to text conversion

Cloud Speech API

Automatic Speech Recognition

Automatic Speech Recognition (ASR) powered by deep learning neural networking to power your applications like voice search or speech transcription.

Global Vocabulary

Recognizes over 80 languages and variants with an extensive vocabulary.

Streaming Recognition

Returns partial recognition results immediately, as they become available.

Inappropriate Content Filtering

Filter inappropriate content in text results.

Real-time or Buffered Audio Support

Audio input can be captured by an application's microphone or sent from a pre-recorded audio file. Multiple audio file formats are supported, including FLAC, AMR, PCMU and linear-16.

Noisy Audio Handling

Handles noisy audio from many environments without requiring additional noise cancellation.

Integrated API

Audio files can be uploaded in the request and, in future releases, integrated with Google Cloud Storage.

Speech API Demo

A close-up photograph of a black microphone with a dense, woven mesh grille. The microphone is positioned on the right side of the frame, angled slightly towards the center. The background is heavily blurred, showing what appears to be a group of people in an outdoor setting with trees and possibly a beach or park area.



Cloud Natural Language API

For sentiment analysis and entity
recognition in a piece of text

Cloud Natural Language API

Syntax Analysis

Extract sentence, identify parts of speech and create dependency parse trees for each sentence.

Entity Recognition

Identify entities and label by types such as person, organization, location, events, products and media.

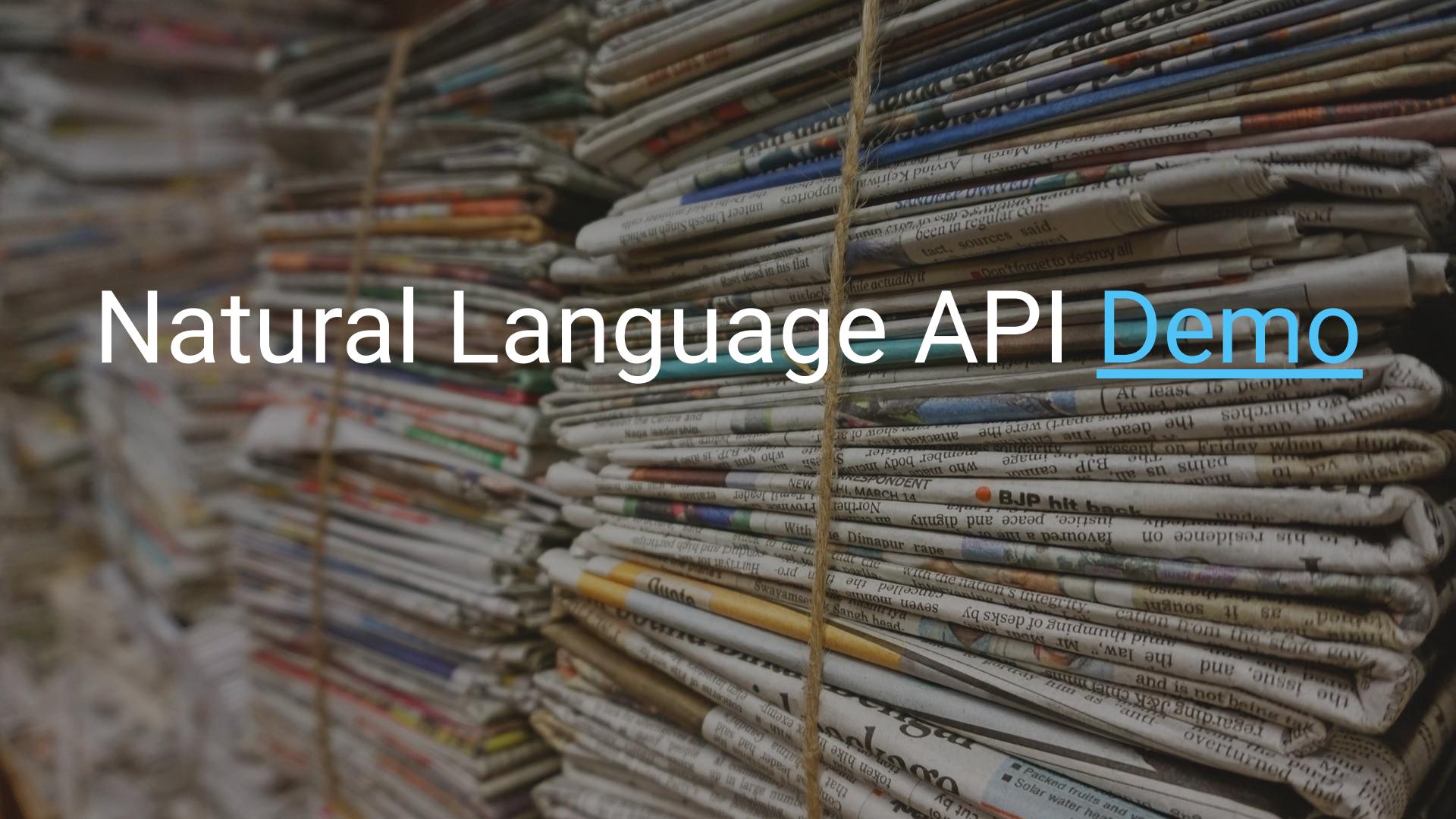
Sentiment Analysis

Understand the overall sentiment of a block of text.

Integrated REST API

Access via REST API. Text can be uploaded in the request or integrated with Google Cloud Storage.

Natural Language API Demo





Cloud Video Intelligence

Analyze your video with Machine Learning

Cloud Video Intelligence API

Label Detection

Detect objects, such as dog, flower, human, in the video.



Video Segmentation

Segment long-running videos to provide annotations for specified time segments.



Face Detection

Detect faces throughout the length of the video.



Shot Change Detection

Detect scene changes within the video.



Integrated REST API

Request one or more annotation types per image.



Regionalization

Specify a region where processing will take place (for regulatory compliance).



Cloud Video Intelligence API

Call API from anywhere.

Video Intelligence API Demo





Cloud Translation API

Dynamically translate between
thousands of available language pairs

Cloud Translation API

Programmatic Access

Accessible via a standard Google REST API. See sample code and libraries for ten different programming languages including Python, Objective C and Ruby.

Text Translation

Supports more than 90 languages and thousands of language pairs.

Language Detection

Detect a document's language and translate it using a RESTful API.

Continuous Updates

Behind the scenes, Translation API is learning from logs analysis and human translation examples.

Adjustable Quota

Easily increase your quota from 2M characters per day to 50M per day or request a higher quota

Translation API Demo

Tensorflow





- **Open source Machine Learning library**
- Especially useful for **Deep Learning**
- For research **and** production
- **Apache 2.0 license**
- v 1.5. Jan 2018
- `$ pip install --ignore-installed --upgrade tensorflow`

Tensorflow

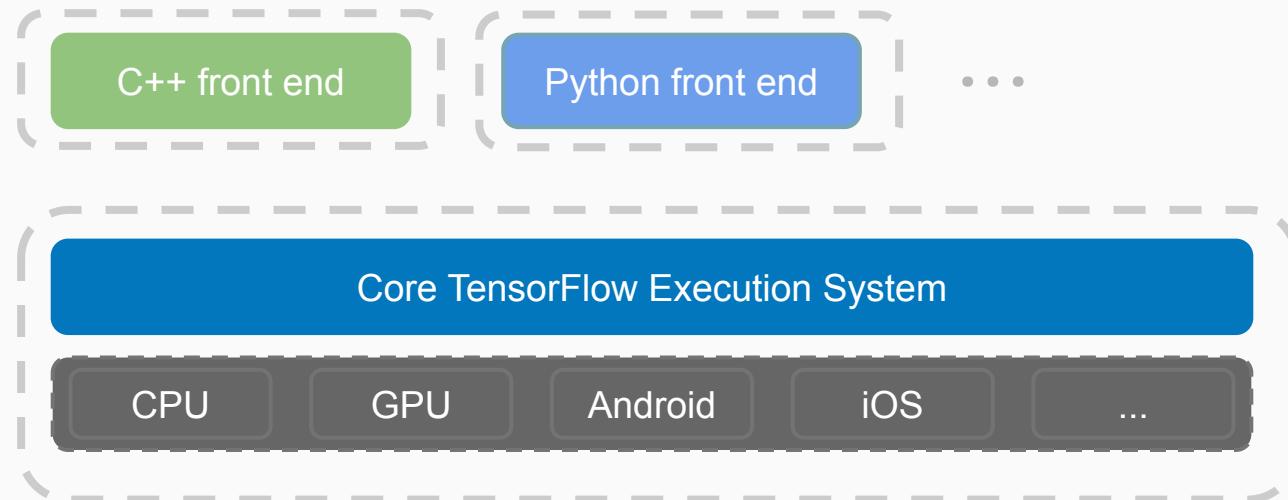
A multidimensional array.



A graph of operations.

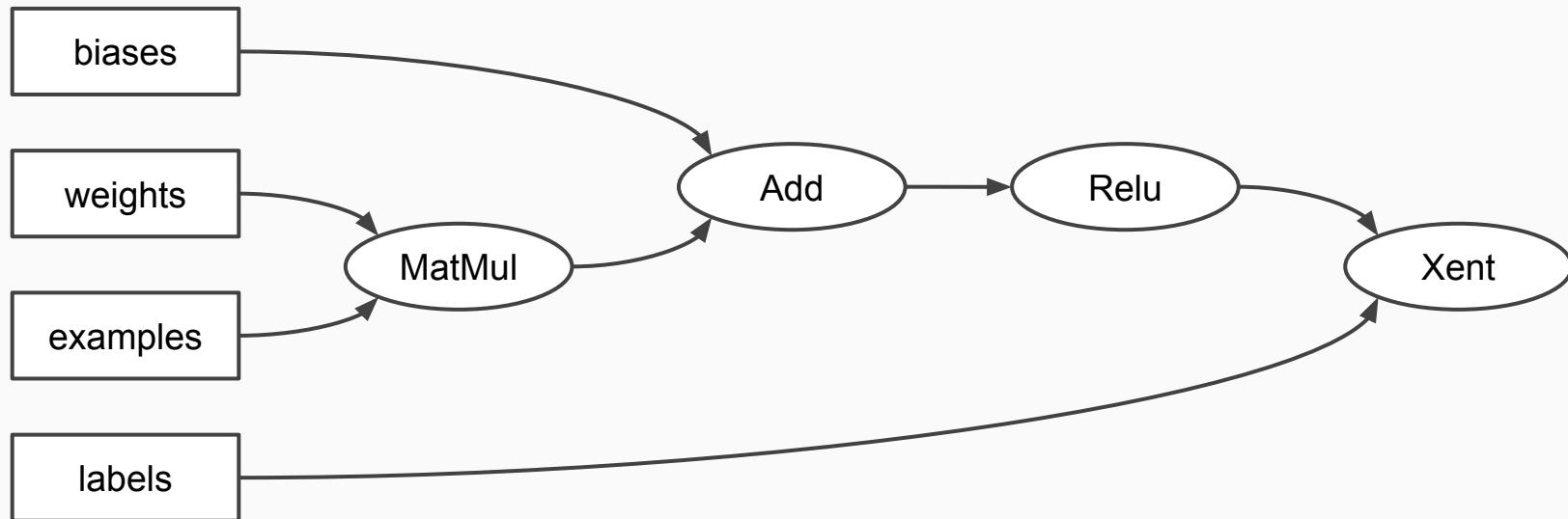
Tensorflow - Engine

- Core in C++
- Supports different backends.
- Frontend in C++ and Python
- Performance Boost with Large-scale Distributed Systems



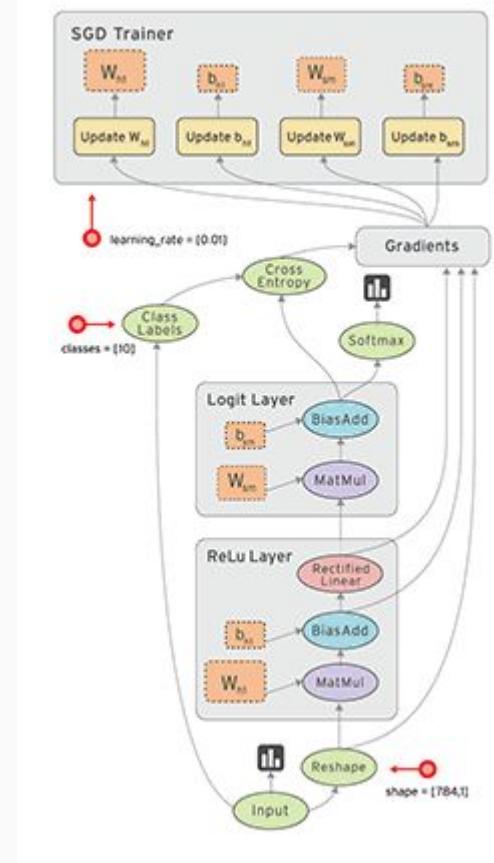
Tensorflow - Graph

- Computation is expressed as a dataflow graph
- Graph of Nodes, also called Operations or ops.



Tensorflow - Graph Execution

- TensorFlow computes set of Ops that must run to compute the outputs
- Ops execute, in parallel, as soon as their inputs are available
- In practice often very complex with 100s or 1000s of nodes and edges



Tensorflow - Code

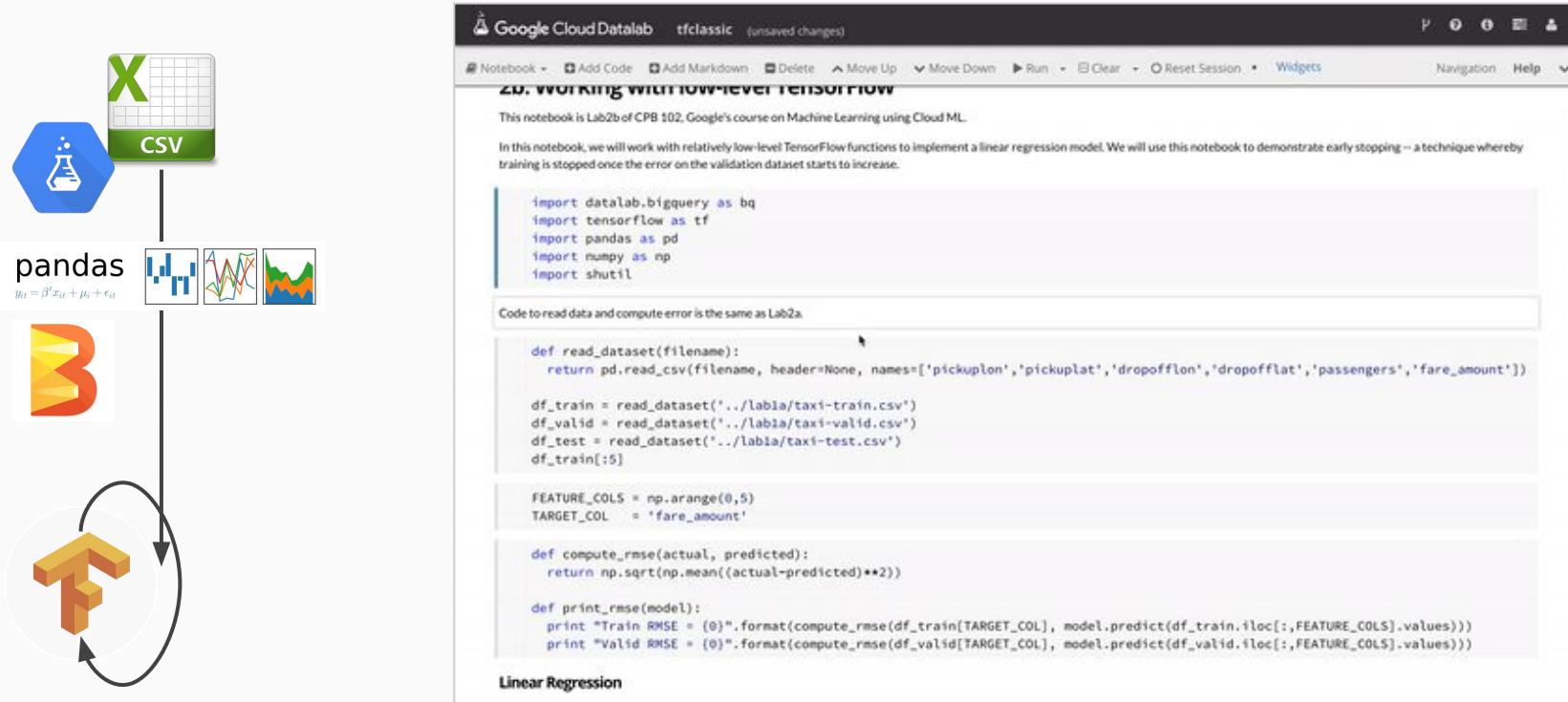
```
1 import tensorflow as tf
2
3 #Define input feature columns
4 sq_footage = tf.contrib.layers.real_valued_column("sq_footage")
5 feature_columns = [sq_footage]
6
7 #Define input function
8 def input_fn(feature_data,label_data=None):
9     return {"sq_footage":feature_data}, label_data
10
11 #Instantiate Linear Regression Model
12 estimator = tf.contrib.learn.LinearRegressor(
13     feature_columns=feature_columns,
14     optimizer=tf.train.FtrlOptimizer(learning_rate=100))
15
16 #Train
17 estimator.fit(
18     input_fn=lambda:input_fn(tf.constant([1000,2000]),
19                             tf.constant([100000,200000])),
20     steps=100)
21
22 #Predict
23 estimator.predict(input_fn=lambda: input_fn([3000]))
```

Tensorflow - Code

```
1 import tensorflow as tf
2
3 #Define input feature columns
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21
22 #Predict
23 estimator.predict(input_fn=lambda: input_fn([3000]))
```

Tensorflow - Datalab local

- In Datalab, start locally on sampled dataset



Cloud ML



Google Cloud Machine Learning Platform

- Training and prediction at Scale
- Fully Managed Platform
- Powered by TensorFlow
- Seamless integration with Google Cloud Platform



Features

- Integrated: Dataflow (Feature processing), Cloud Storage (Data storage) and Datalab (Model definition)
- Hypertune. Build better performing models faster by automatically tuning your hyperparameters
- Managed service. Focus on model development and prediction without worrying about the infrastructure
- Scalable service. Build models of any data size or type using managed distributed training infrastructure that supports CPUs and GPUs.
- Portable models.



Google Cloud Platform is making GPUs available worldwide.

NVIDIA Tesla K80 and P100 GPUs are available today.



AMD FirePro S9300 x2



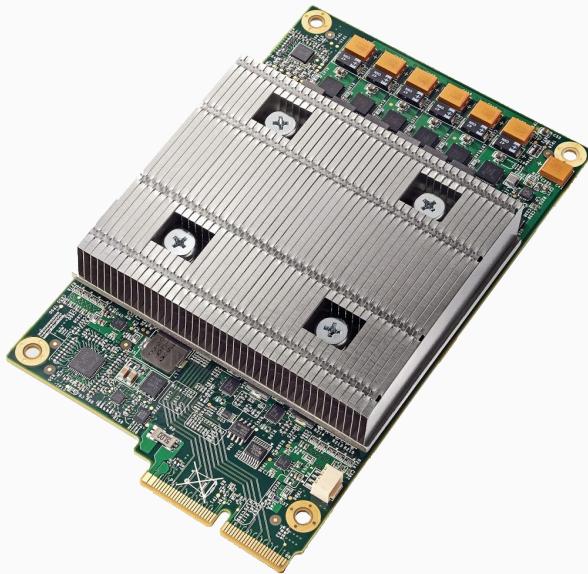
NVIDIA Tesla P100



NVIDIA Tesla K80s

Tensorflow Processing Unit

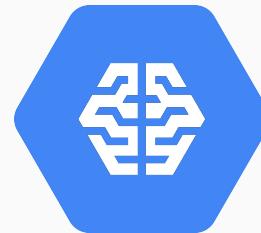
Each Cloud TPU offers up to 180 teraflops of computing performance as well as 64 gigabytes of ultra-high-bandwidth memory.



Three steps for success with Machine Learning



Get your arms around
Big Data.



Invest time in understanding
Machine Learning.



Talent. Data Scientist with ML
experience.

High-level “out-of-box” API
compatible with scikit-learn

Components useful when building
custom NN models

Python API gives you full control

C++ API is quite low-level

TF runs on different hardware

<http://scikit-learn.org/>

Estimator API

`tf.layers, tf.losses, tf.metrics`

Core TensorFlow (Python)

Core TensorFlow (C++)

CPU

GPU

TPU

Android

Run TF
at scale

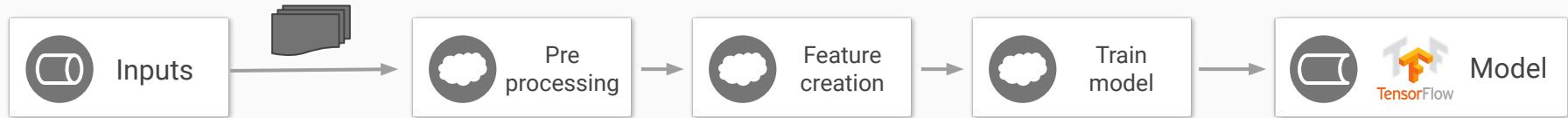
Many Machine Learning frameworks can handle toy problems



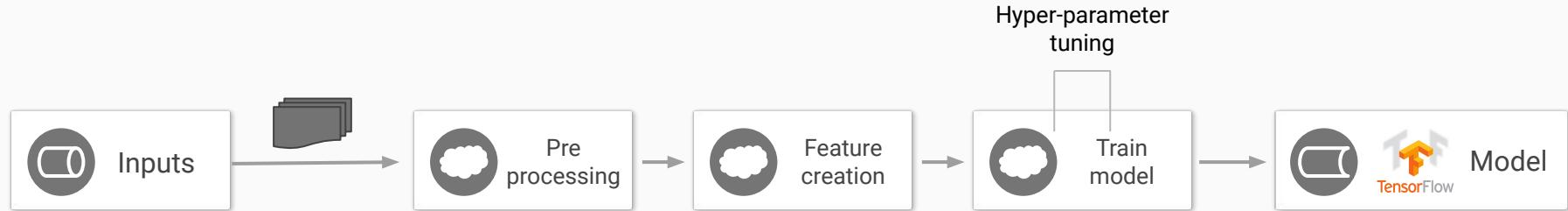
As your data size increases, batching and distribution become important



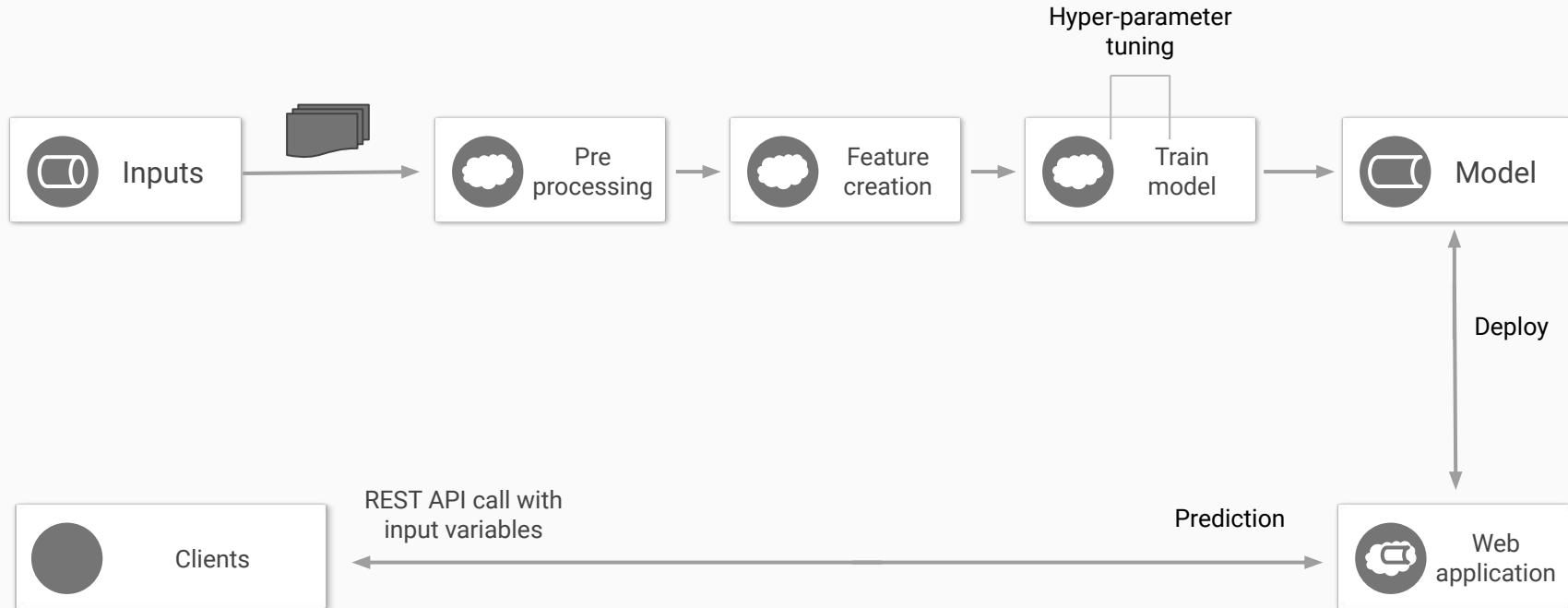
Input necessary transformations



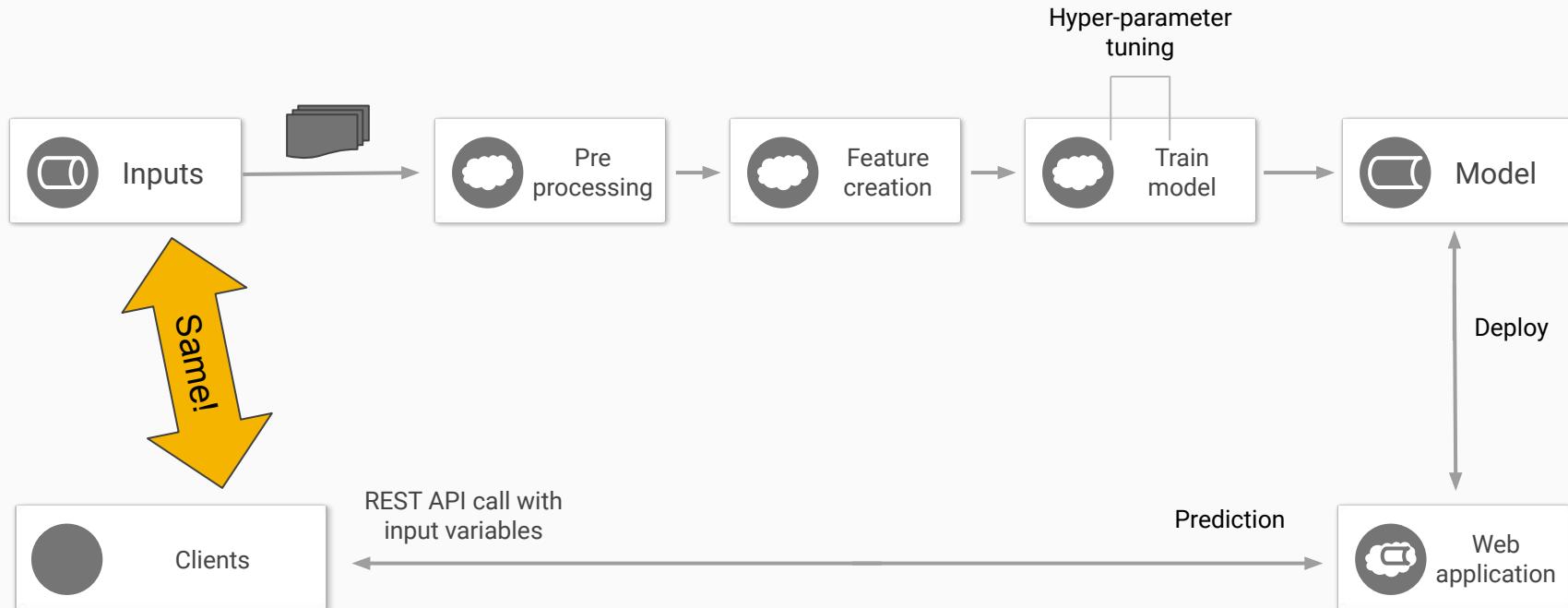
Hyperparameter tuning might be nice



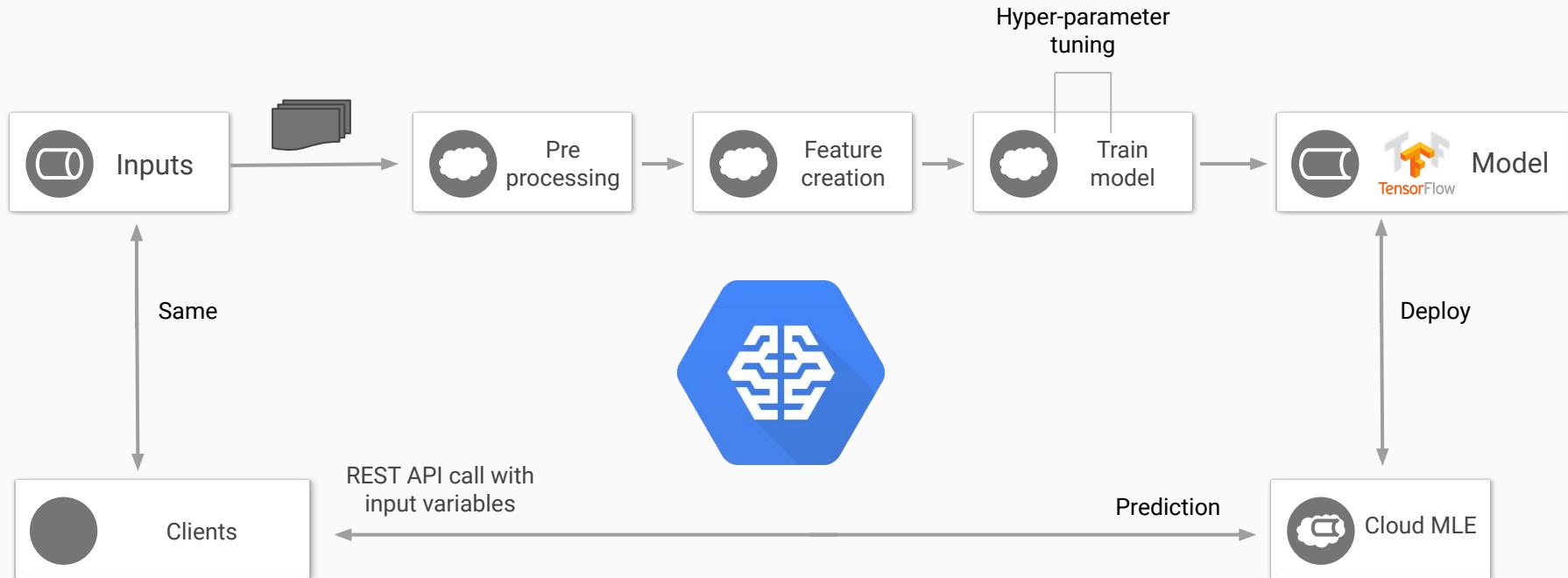
Need to autoscale prediction code



Who does the preprocessing?

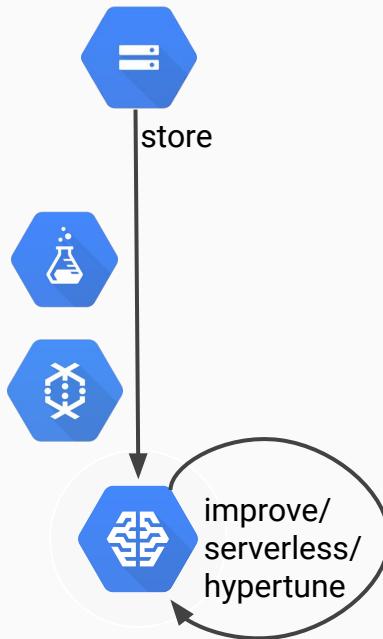


Cloud Machine Learning—repeatable, scalable, tuned



Tensorflow - Datalab Cloud ML

- Then, scale it out to GCP using serverless technology



Google Cloud Datalab clouddml (autosaved)

Notebook Add Code Add Markdown Delete Move Up Move Down Run Clear Reset Session Widgets Navigation Help

Training on cloud

In order to train on the cloud, we have to copy the model and data to our bucket on Google Cloud Storage (GCS).

```
%bash
rm -rf taxifare.tar.gz taxi_trained
tar cvfz taxifare.tar.gz taxifare
gsutil cp taxifare.tar.gz gs://${BUCKET}/taxifare/source/taxifare.tar.gz
gsutil cp ./labla/*.csv gs://${BUCKET}/taxifare/input/
gsutil -m rm -r -f gs://${BUCKET}/taxifare/taxi_preproc
gsutil -m rm -r -f gs://${BUCKET}/taxifare/taxi_trained
```

Running...

When you run your preprocessor, you have to change the input and output to be on GCS.

Using DirectPipelineRunner runs Dataflow locally, but the inputs & outputs are on the cloud. Using BlockingDataflowPipelineRunner will use Cloud Dataflow (and take much longer because of the overhead involved for such a small dataset). To see the status of your BlockingDataflowPipelineRunner job, visit <https://console.cloud.google.com/dataflow>

```
# imports
import apache_beam as beam
import google.cloud.ml as ml
import google.cloud.ml.dataflow.io.tfrecordio as tfrecordio
import google.cloud.ml.io as io
import os

# Change as needed
#RUNNER = 'DirectPipelineRunner' #
RUNNER = 'BlockingDataflowPipelineRunner'

# defines
feature_set = TaxifareFeatures()
OUTPUT_DIR = 'gs://{}/taxifare/taxi_preproc'.format(BUCKET)
```

Cloud Auto ML

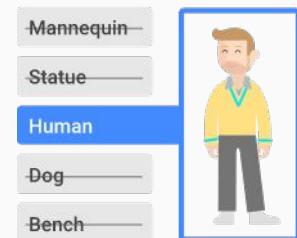


Cloud AutoML

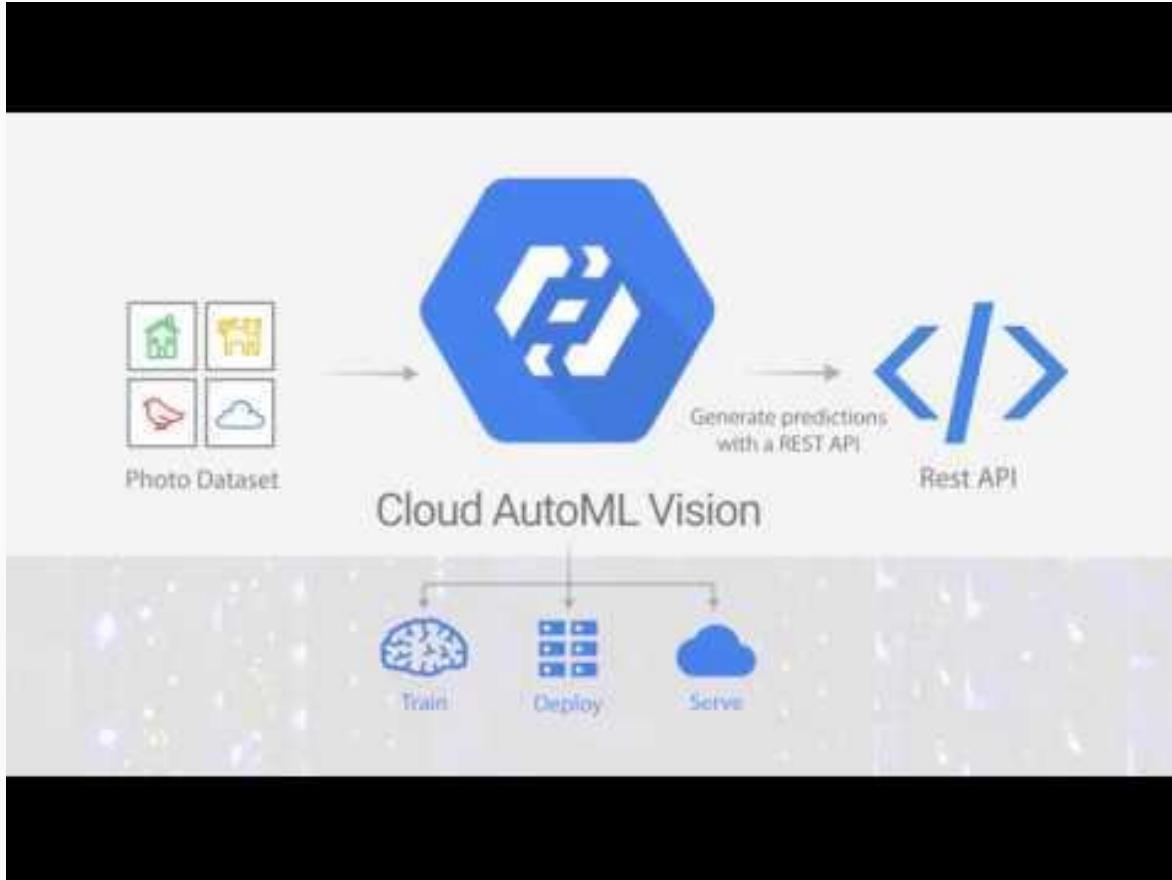
Train high quality custom machine learning models with minimum effort and machine learning expertise

Cloud AutoML is a suite of Machine Learning products that enables developers with limited machine learning expertise to train high quality models by leveraging Google's state of the art transfer learning, and Neural Architecture Search technology.

AutoML Vision is the first product to be released. It is a simple, secure and flexible ML service that lets you train custom vision models for your own use cases. Soon, Cloud AutoML will release other services for all other major fields of AI.



Cloud AutoML Vision



Ejercicio AutoML



Classify images of clouds in the cloud with AutoML Vision

36 min

Updated Jun 17, 2019



Start

Ejercicio Tensorflow

Tensorflow



A thumbnail for a video course titled "End-to-end Machine Learning with Tensorflow on GCP". The thumbnail features a blue header with the Google Cloud logo and a timer icon indicating a duration of 213 minutes. Below the header, the title is displayed in white text. At the bottom, there is a "START" button and a timestamp indicating the video was last updated on Jan 23, 2018.

¿ Preguntas ?

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