Intro a **Redes Neuronales** con Keras

Rodolfo Ferro.

CONISOFT 2018 S.L.P.

GitHub Campus Experts

¡Qué onda!

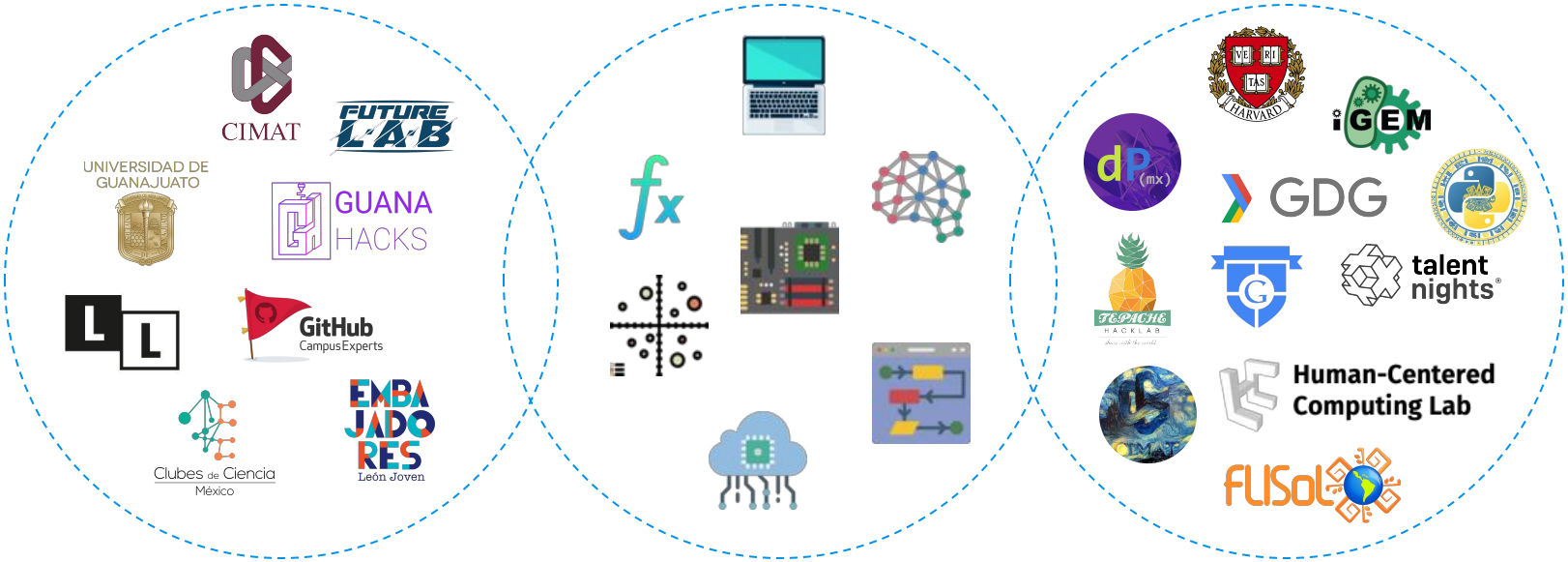
Soy Rodo Ferro

Computer-
Mathemagician $f[$ 💻 $]$
GitHub Campus Expert

Encuéntrame:

@FerroRodolfo
@rodo_ferro

Lo que hago: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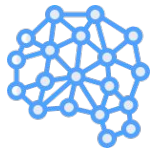
Objetivos:

- Contextualizar sobre IA
- Entender bases de redes neuronales
- Conocer Keras, framework para desarrollar redes neuronales con Python
- Desarrollar un modelo de clasificación

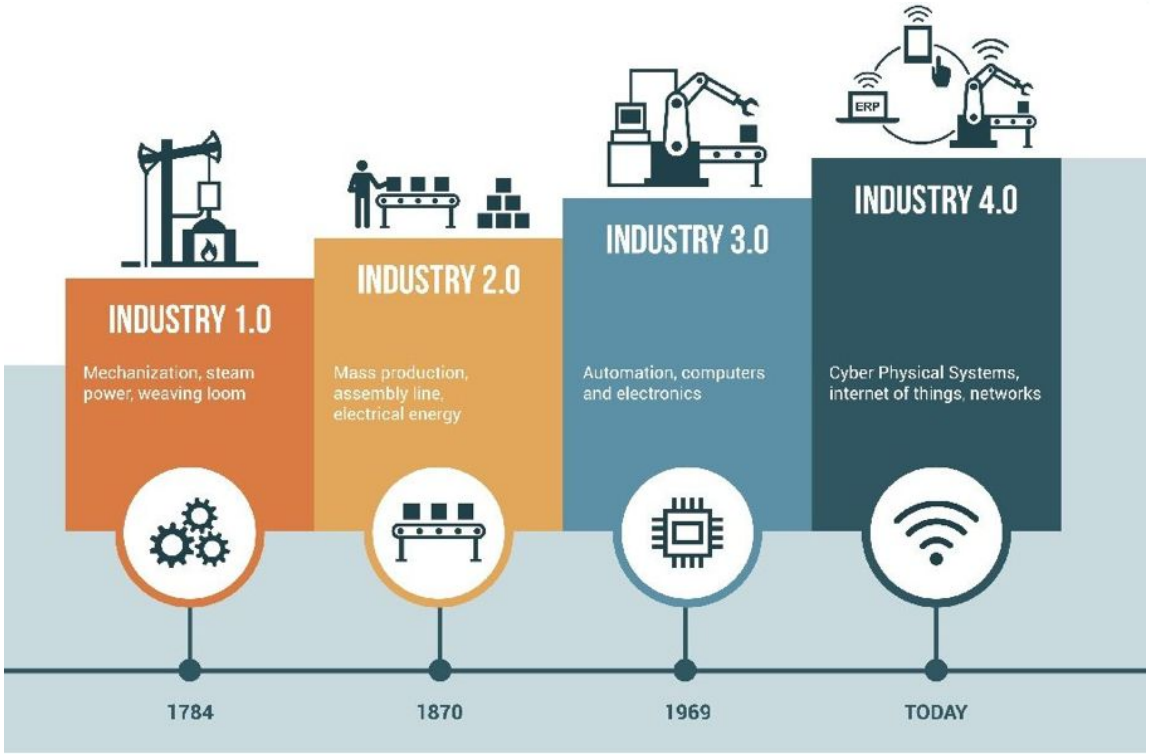
+ Mostrar un servicio web que utiliza una red neuronal entrenada...



1.
Contexto

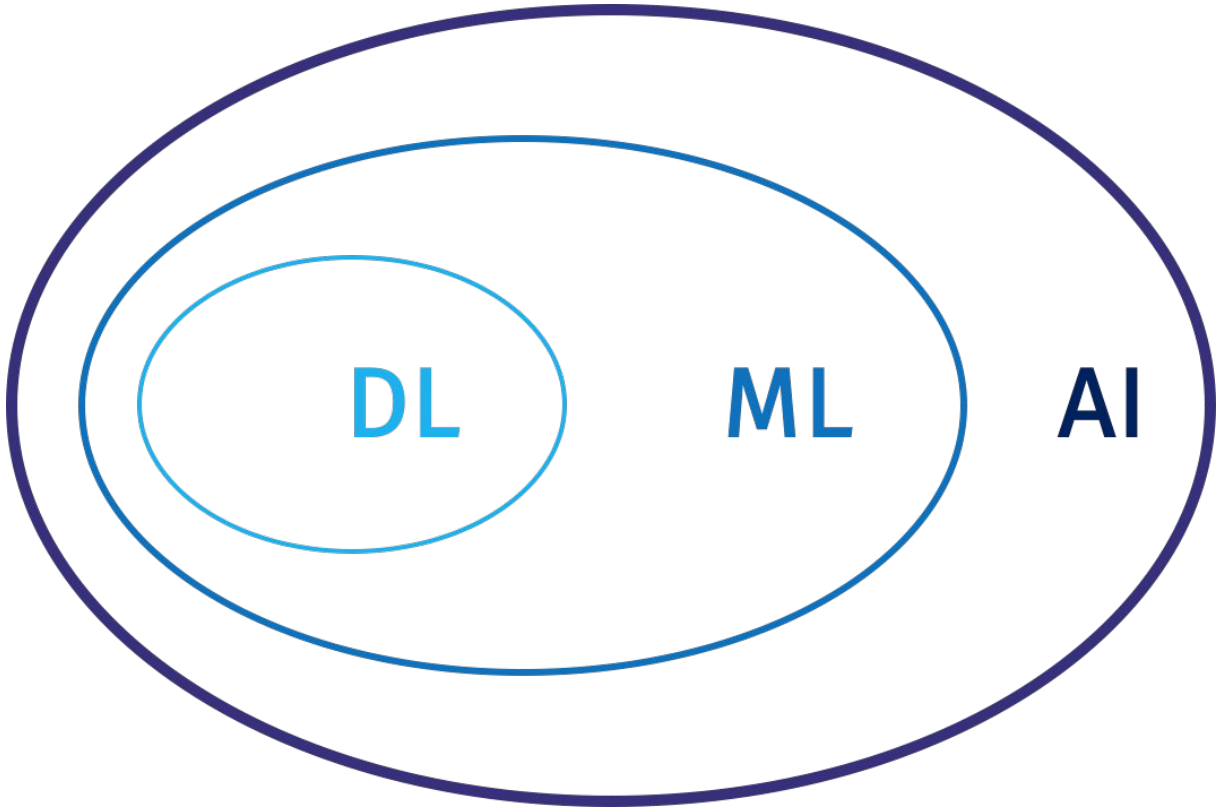
Situación actual y relevancia

RI4.0

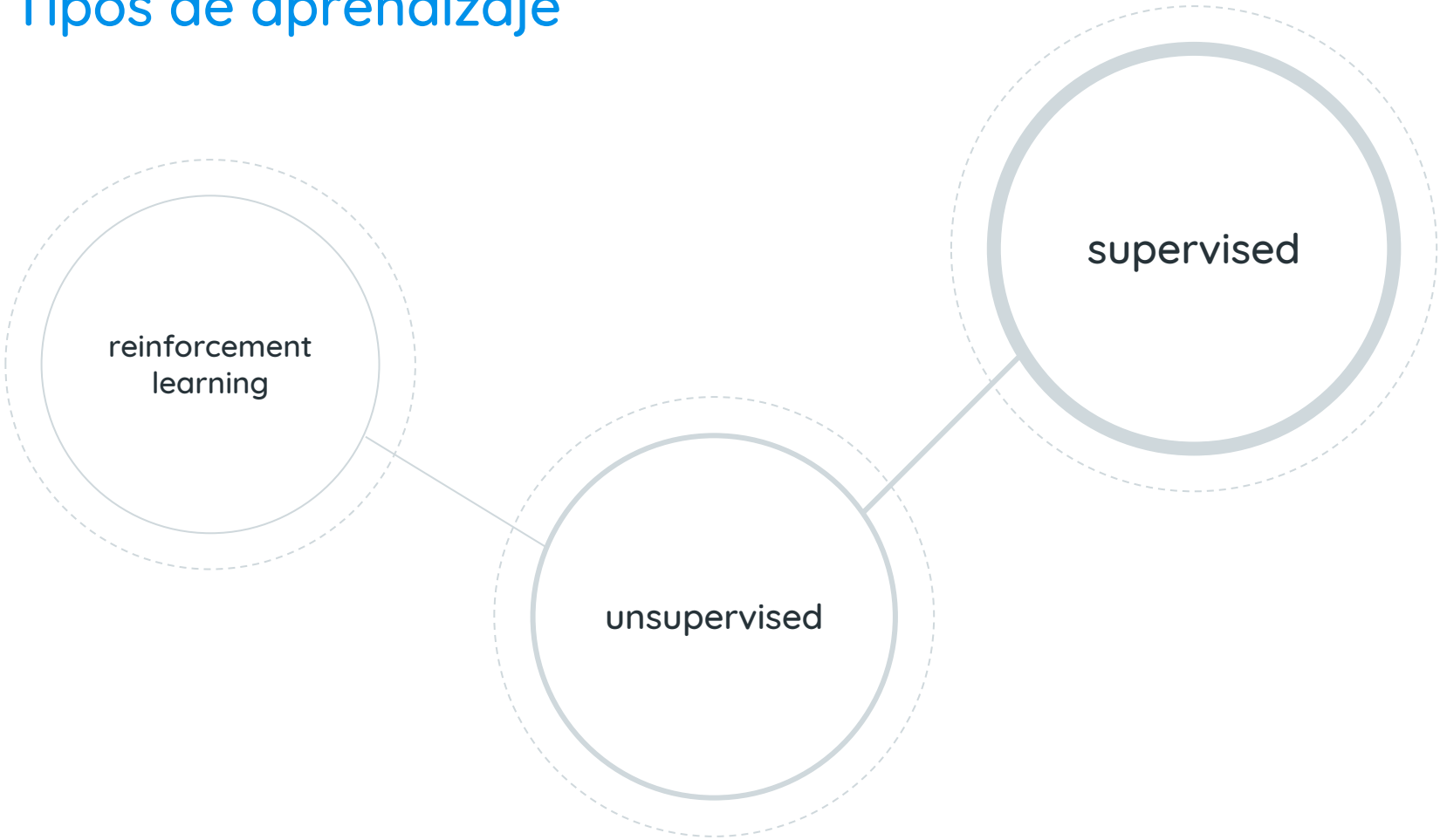


Fuente: Industry 4.0 and Industrial IoT in Manufacturing: A Sneak Peek, Aberdeen Essentials.

AI, ML, DL

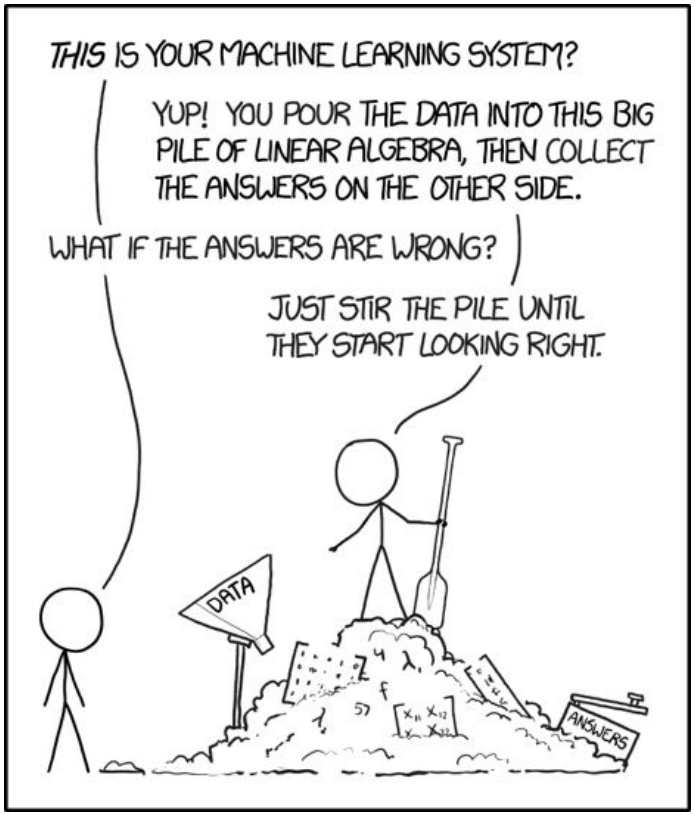


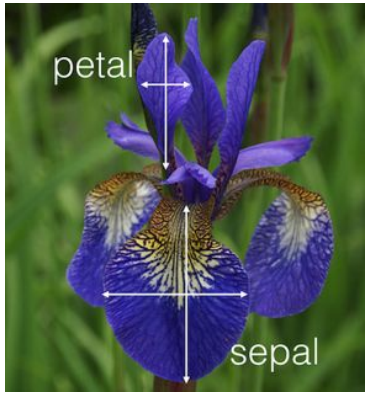
Tipos de aprendizaje

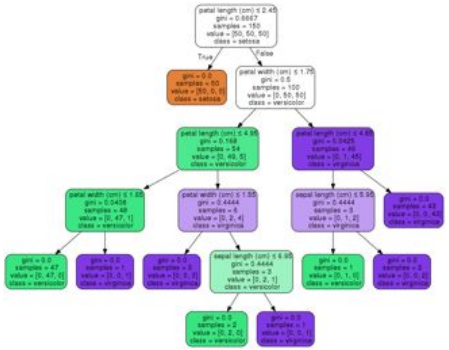


Distintos modelos:

Probabilidad, estadística y álgebra lineal con esteroides





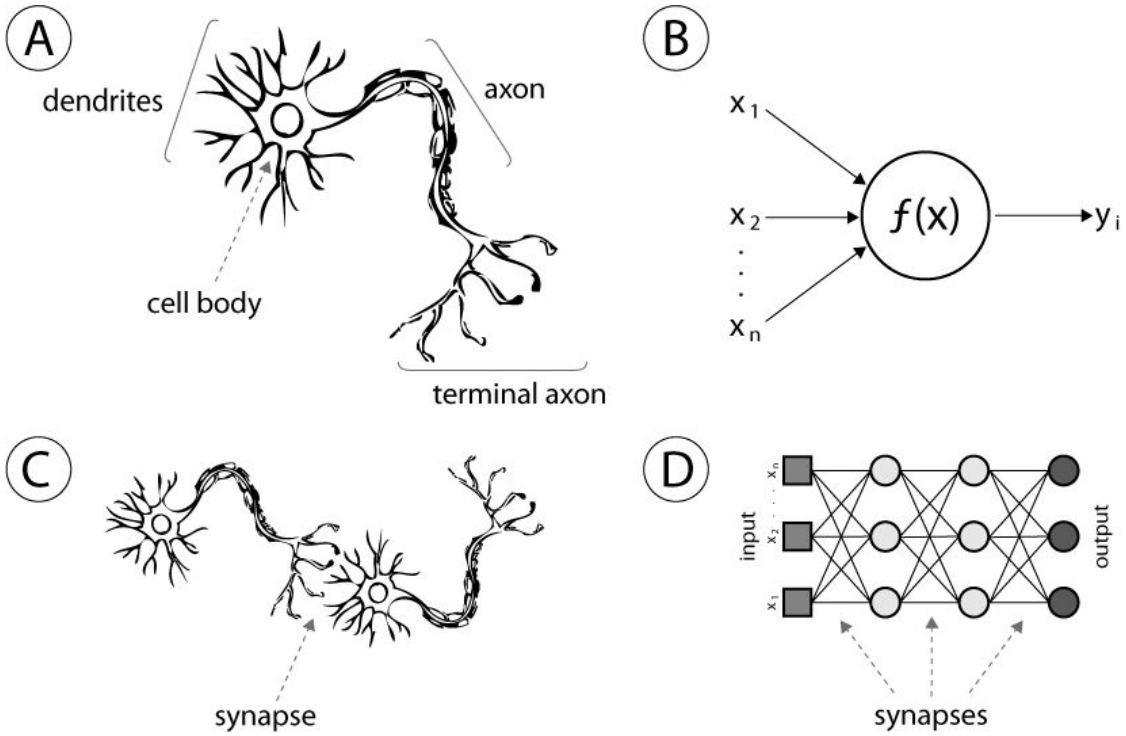


2.
Redes neuronales

Aprendizaje inspirado en el funcionamiento cerebral

*Las ANNs son modelos computacionales **bio-inspirados** por el sistema nervioso de los seres vivos. Las ANNs pueden ser definidas como un conjunto de unidades de procesamiento (neuronas artificiales), interconectadas por matrices de pesos sinápticos (sinapsis artificiales), que pueden ser implementadas por vectores y matrices de pesos sinápticos (da Silva, Spa , Flauzino, Liboni, & dos Reis Alves, 2017).*

Modelo bio-inspirado



Fuente: *da Silva, Spa , Flauzino, Liboni, & dos Reis Alves, 2017.*

Estructura

Una ANN puede ser dividida en tres partes llamadas capas, que son conocidas como:

1. ***Input layer* (capa de entrada)**
   Esta capa recibe información, la cual puede ser señales, características, imágenes crudas o medidas del entorno. Estos inputs usualmente son normalizados. Esta normalización tiene como resultado mejores resultados de precisión numérica en las operaciones realizadas por la red.

Estructura

Una ANN puede ser dividida en tres partes llamadas capas, que son conocidas como:

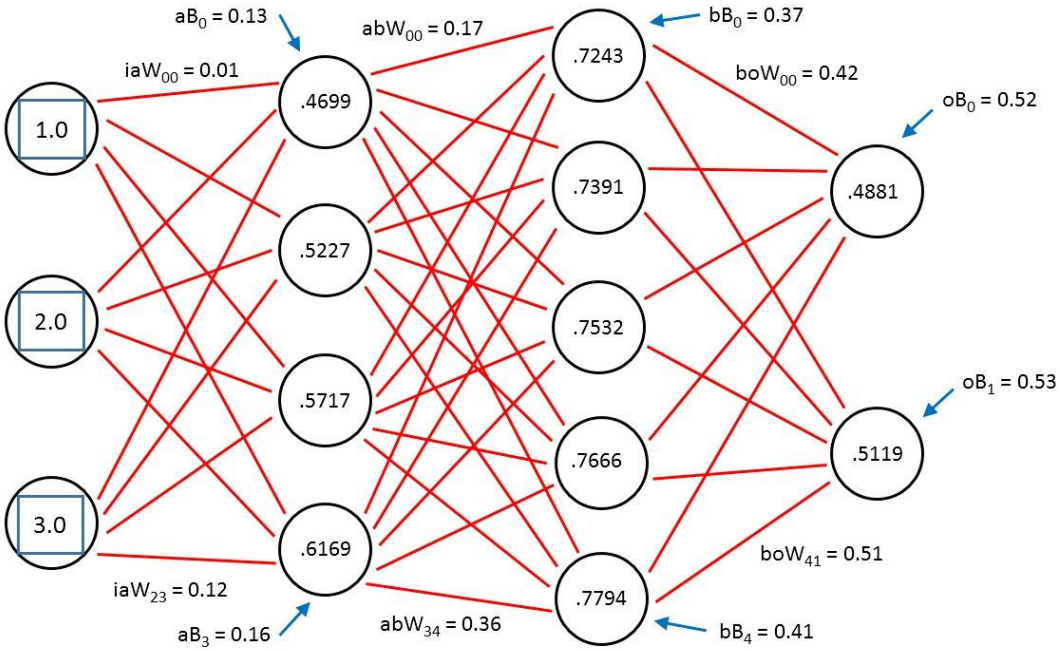
2. ***Hidden layers* (capas ocultas)**
   Estas capas están compuestas por neuronas que responden extrayendo patrones asociados con el proceso o sistema analizado. Estas capas realizan la mayoría delprocesamiento interno de una ANN.

Estructura

Una ANN puede ser dividida en tres partes llamadas capas, que son conocidas como:

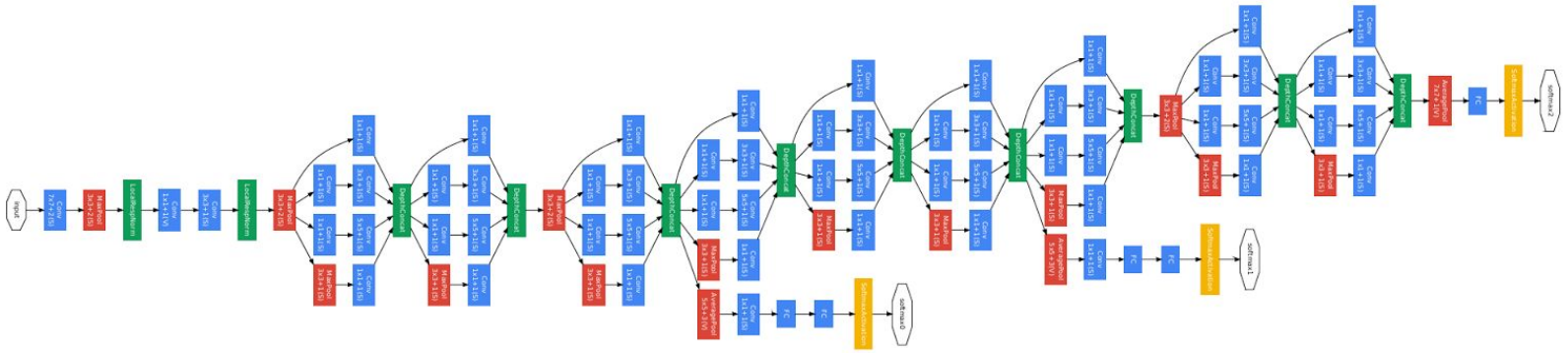
3. ***Output layer* (capa de salida)**
   Esta capa compuesta también de neuronas es la responsable de producir y presentar las salidas finales de la red, que resultan del procesamiento realizado por las capas previas.

Capas, como las cebollas:



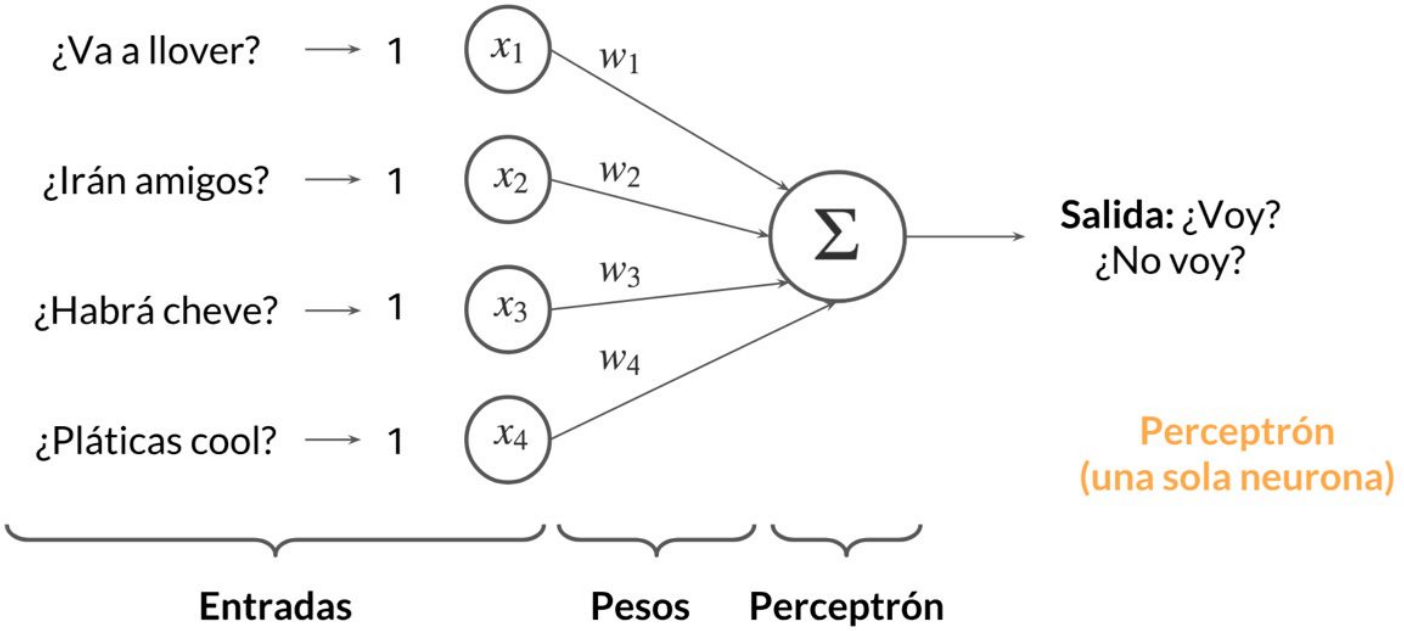
Fuente: "DEEP NEURAL NETWORKS: A GETTING STARTED TUTORIAL, PART #1", Sergey Golubev, 2014.

Capas, como las cebollas:



Fuente: “ Going Deeper with Convolutions”, Szegedy *et al.*, 2014.

¿Voy al CONISOFT 2018?



¿Cómo se programa?

```python
import numpy as np

class Perceptron():
    def __init__(self, entradas, pesos):
        """Constructor de la clase."""
        self.n = len(entradas)
        self.entradas = np.array(entradas)
        self.pesos = np.array(pesos)

    def voy_no_voy(self, umbral):
        """Calcula el output deseado."""
        si_no = (self.entradas @ self.pesos) >= umbral
        if si_no: return "Sí voy."
        else: return "No voy."
```

```
import numpy as np

class SigmoidNeuron():
    def __init__(self, n):
        np.random.seed(123)
        self.synaptic_weights = 2 * np.random.random((n, 1)) - 1

    def __sigmoid(self, x):
        return 1 / (1 + np.exp(-x))

    def __sigmoid_derivative(self, x):
        return x * (1 - x)

    def train(self, training_inputs, training_output, iterations):
        for iteration in range(iterations):
            output = self.predict(training_inputs)
            error = training_output.reshape((len(training_inputs), 1)) - output
            adjustment = np.dot(training_inputs.T, error *
                                self.__sigmoid_derivative(output))
            self.synaptic_weights += adjustment

    def predict(self, inputs):
        return self.__sigmoid(np.dot(inputs, self.synaptic_weights))
```

La magia detrás:

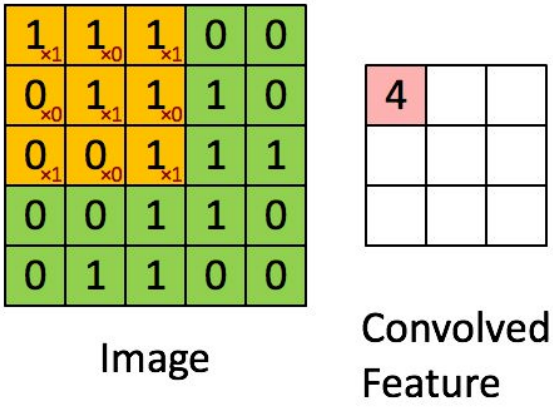
Operaciones que ayudan a comprender la esencia de las cosas.

Operaciones mágicas:

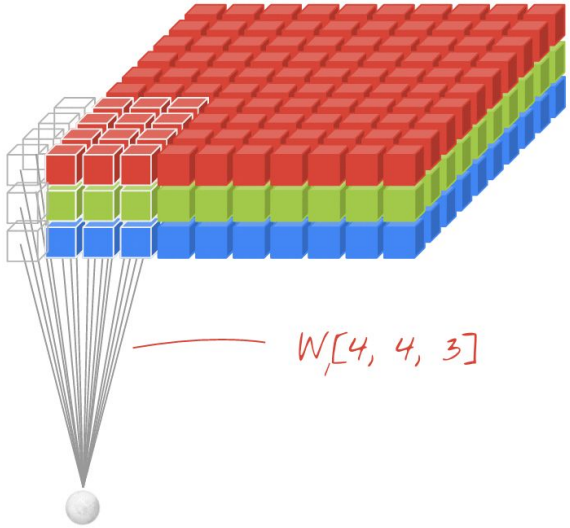
$$(f * g)(t) \stackrel{\text{def}}{=} \int_{-\infty}^{\infty} f(\tau) g(t - \tau)\, d\tau$$

$$= \int_{-\infty}^{\infty} f(t - \tau) g(\tau)\, d\tau.$$

Operaciones mágicas:



Fuente: "Convolution sliding window", NVIDIA Blog.



Fuente: "2D Convolutional Animation", Martin Görner.

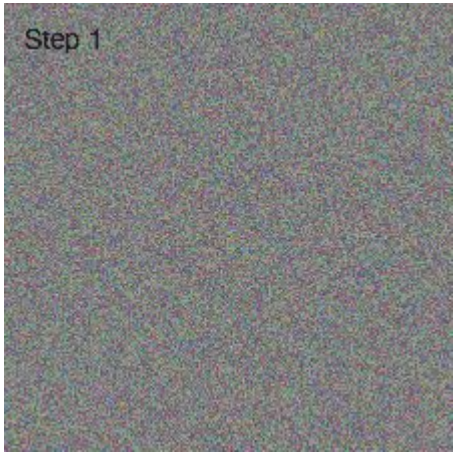
Operaciones mágicas:

“Representation Learning”.

Representación = *Feature*

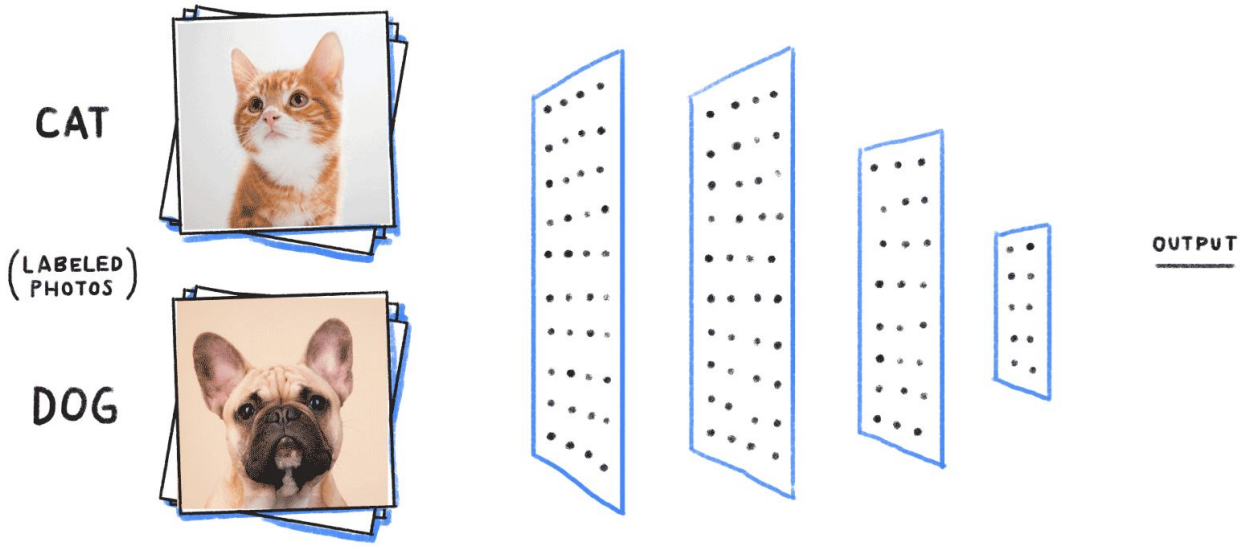
Input - Una imagen
Representación - No hay esquinas
Modelo - Crea una representación y aplica la regla para detectar la forma.

Fuente: “What is representation learning in deep learning?”, Quora.



Fuente: “Keras Visualization Toolkit”, Raghavendra Kotikalapudi.

Operaciones mágicas:

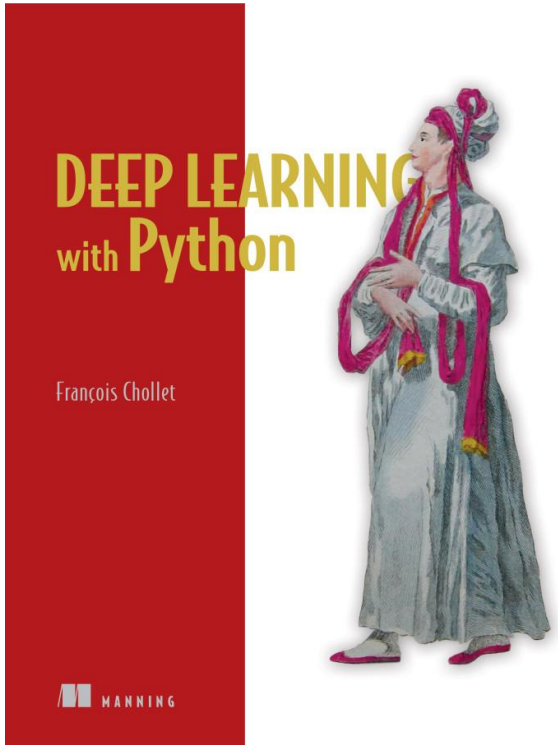


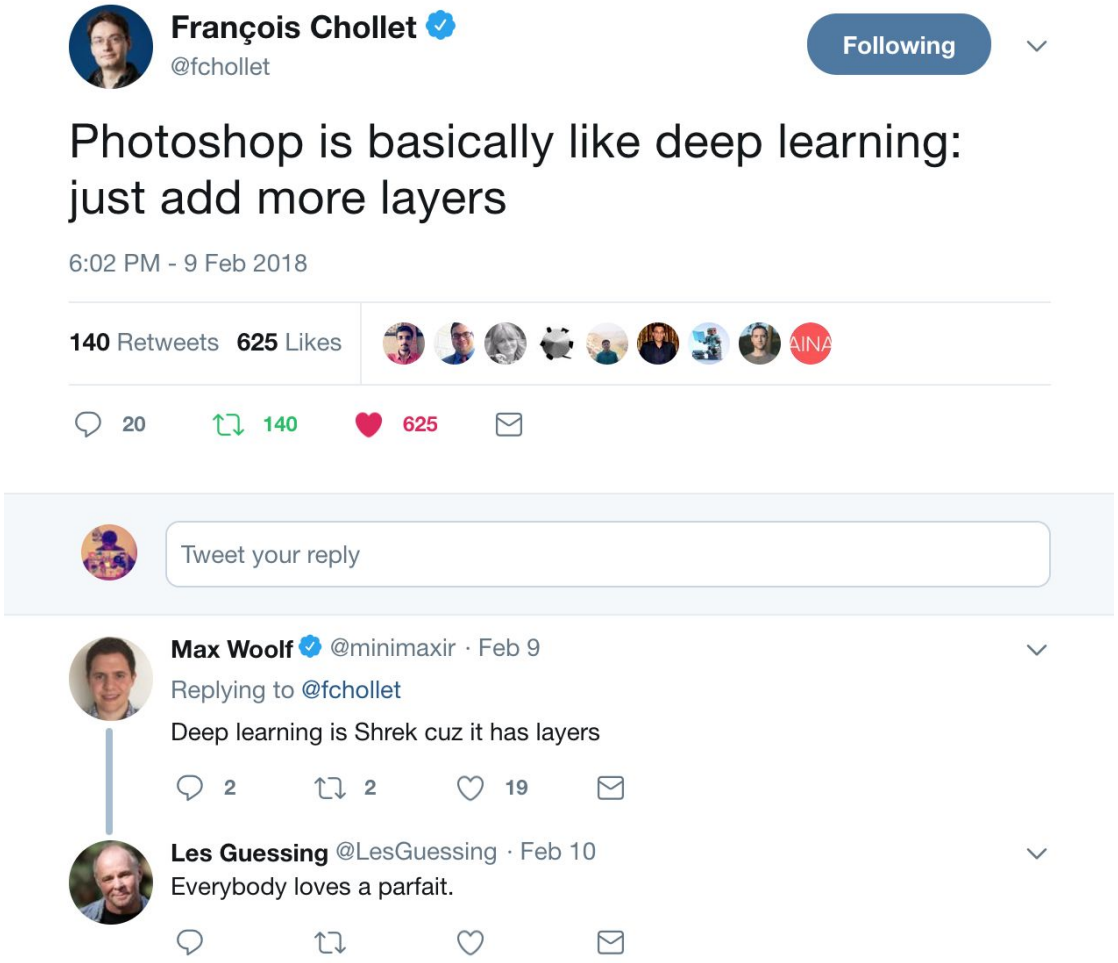
Fuente: “Simple Image Classification using Convolutional Neural Network — Deep Learning in python.”, Venkatesh Tata.

3.
Keras

The Python Deep Learning Library:
Redes neuronales en lenguaje humano

François Chollet





Fuente: https://twitter.com/fchollet/status/962144774802227205

Keras: The Python Deep Learning library

You have just found Keras.

Keras is a high-level neural networks API, written in Python and capable of running on top of TensorFlow, CNTK, or Theano. It was developed with a focus on enabling fast experimentation. *Being able to go from idea to result with the least possible delay is key to doing good research.*

Source: https://keras.io/

Guiding principles

- **User friendliness.** Keras is an API designed for human beings, not machines. It puts user experience front and center.

  Keras follows best practices for reducing cognitive load: it offers consistent & simple APIs, it minimizes the number of user actions required for common use cases, and it provides clear and actionable feedback upon user error.
- **Modularity.** A model is understood as a sequence or a graph of standalone, fully-configurable modules that can be plugged together with as little restrictions as possible. In particular, neural layers, cost functions, optimizers, initialization schemes, activation functions, regularization schemes are all standalone modules that you can combine to create new models.
- **Easy extensibility.** New modules are simple to add (as new classes and functions), and existing modules provide ample examples. To be able to easily create new modules allows for total expressiveness, making Keras suitable for advanced research.
- **Work with Python.** No separate models configuration files in a declarative format. Models are described in Python code, which is compact, easier to debug, and allows for ease of extensibility.

Source: https://keras.io/

Keras en 1 minuto:

La estructura principal de Keras es un modelo, que es una manera en la que organizamos las capas. El modelo más sencillo es el modelo **Sequential**, una pila lineal de capas. Para modelos más elaborados, usamos **Model**, con la programacion funcional del API de Keras.

```
# Import the Sequential model:
from keras.models import Sequential

# Create a new Sequential model:
model = Sequential()
```

Keras en 1 minuto:

Añadir capas es tan sencillo como utilizar **.add()**.

```
# Import the Dense layer class for FC:
from keras.layers import Dense

# Add FC layers:
model.add(Dense(units=64, activation='relu', input_dim=100))
model.add(Dense(units=10, activation='softmax'))
```

Keras en 1 minuto:

Una vez se tenga el modelo, configuramos su proceso de aprendizaje utilizando **.compile()**.

```
# Compile model:
model.compile(loss='categorical_crossentropy',
              optimizer='sgd',
              metrics=['accuracy'])
```

Keras en 1 minuto:

Una vez compilado el modelo, puede procederse a iterar en los lotes de entrenamiento usando **.fit()**.

```
# Train the model:
# x_train and y_train are Numpy arrays
# --just like in the Scikit-Learn API.
model.fit(x_train, y_train, epochs=5, batch_size=32)
```

Keras en 1 minuto:

Finalmente se puede evaluar el desempeño, o generar predicciones de nuevos datos:

```
# Evaluate the model:
loss_and_metrics = model.evaluate(x_test, y_test, batch_size=128)

# Make predictions:
classes = model.predict(x_test, batch_size=128)
```

Keras *Layers:*

- Core:
  - Dense
  - Activation
  - Dropout
  - Flatten
  - Input
  - Reshape
  - Permute
  - ...
- Convolutional:
  - Conv1D
  - Conv2D
  - Conv3D
  - ...
- Pooling:
  - MaxPooling1D
  - MaxPooling2D
  - MaxPooling3D
  - AveragePooling1D
  - AveragePooling2D
  - AveragePooling3D
  - GlobalMaxPooling1D
  - ...
- Locally-connected
- Recurrent
- Embedding
- Merge
- Normalization
- ...

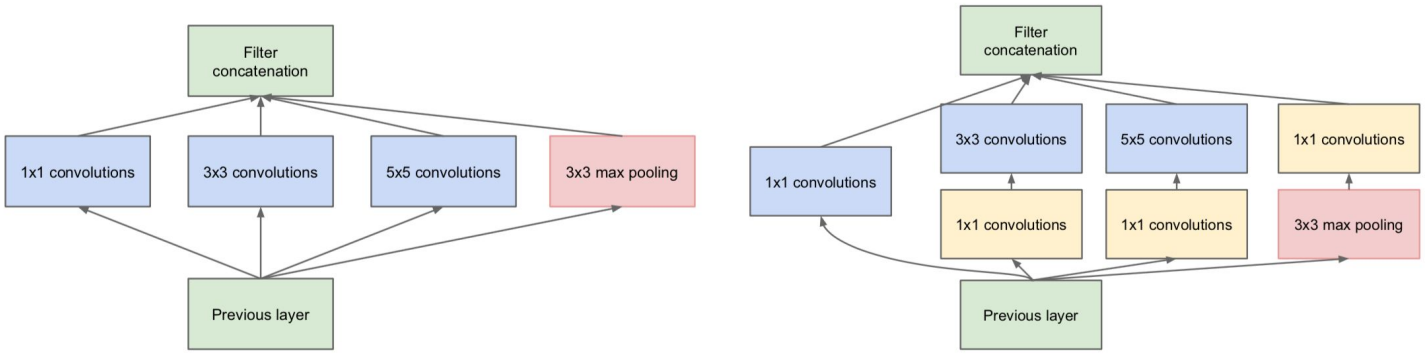
Keras *Preprocessing:*

- Sequence preprocessing
- Image preprocessing
- Text preprocessing

...

Metrics, Losses, Activations, Optimizers, Initializers, Regularizers, Datasets...

¿Y si quisiera hacer un **módulo *inception***?

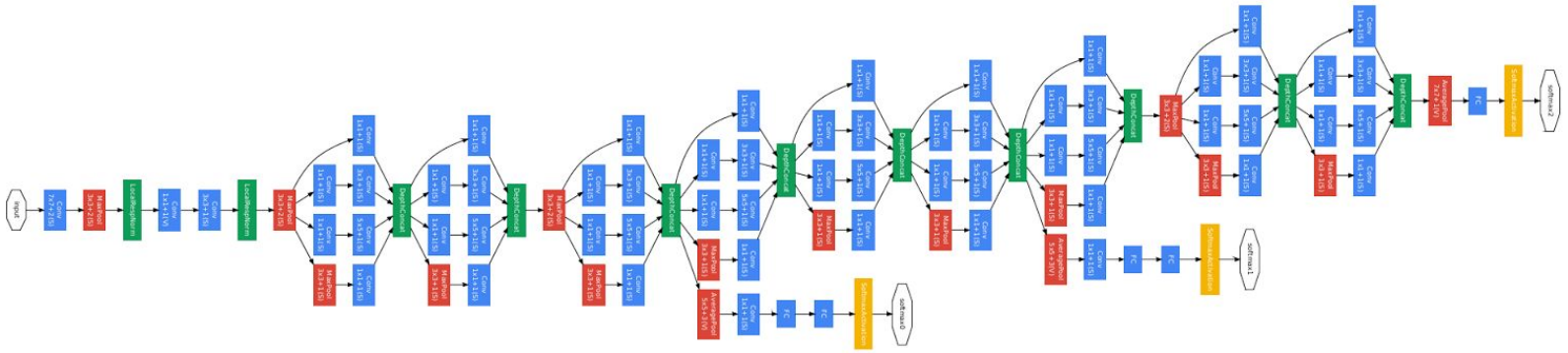


(a) Inception module, naïve version (b) Inception module with dimension reductions

Figure 2: Inception module

Fuente: " Going Deeper with Convolutions", Szegedy *et al.*, 2014.

Capas, como las cebollas:



Fuente: “ Going Deeper with Convolutions”, Szegedy *et al.*, 2014.

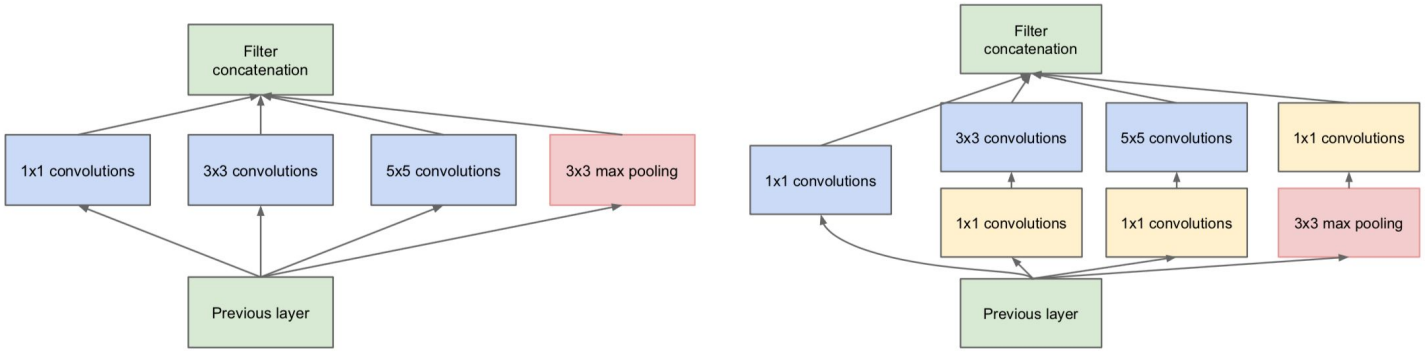
Keras Fuctional API:

La API funcional de Keras es el camino a seguir para definir modelos complejos, como modelos de múltiples salidas, gráficos acíclicos dirigidos o modelos con capas compartidas.

Keras Functional API:

```
from keras.layers import Conv2D, MaxPooling2D, Input

input_img = Input(shape=(256, 256, 3))

tower_1 = Conv2D(64, (1, 1), padding='same', activation='relu')(input_img)
tower_1 = Conv2D(64, (3, 3), padding='same', activation='relu')(tower_1)

tower_2 = Conv2D(64, (1, 1), padding='same', activation='relu')(input_img)
tower_2 = Conv2D(64, (5, 5), padding='same', activation='relu')(tower_2)

tower_3 = MaxPooling2D((3, 3), strides=(1, 1), padding='same')(input_img)
tower_3 = Conv2D(64, (1, 1), padding='same', activation='relu')(tower_3)

output = keras.layers.concatenate([tower_1, tower_2, tower_3], axis=1)
```

Módulo *inception*:



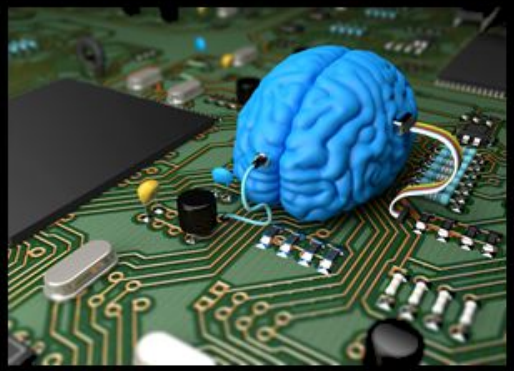
(a) Inception module, naïve version (b) Inception module with dimension reductions

Figure 2: Inception module

Fuente: " Going Deeper with Convolutions", Szegedy *et al.*, 2014.

Deep Learning

What society thinks I do



What my friends think I do

What other computer scientists think I do

What mathematicians think I do

What I think I do

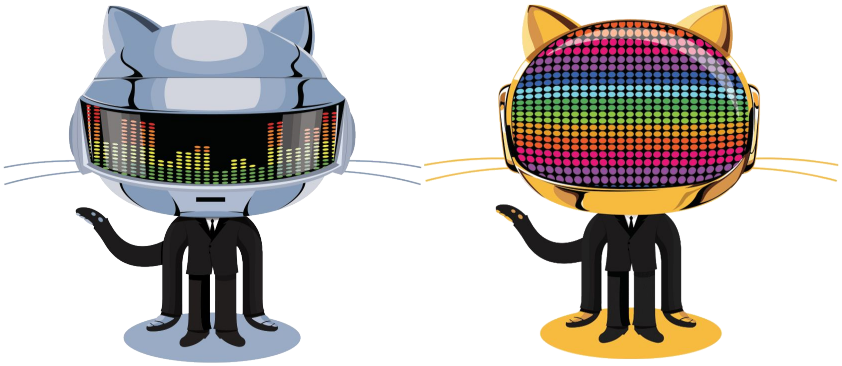
```
In [1]:
import keras
Using TensorFlow backend.
```

What I actually do

4.
Manos a la obra

A escribir código...

Antes de continuar...



https://github.com/RodolfoFerro/CONISOFT2018

Fork it, clone it, cut it, paste it, load it, check it, quick, rewrite it...

– Daft Punk (ft. Rodolfo Ferro)

Antes de continuar...

https://colab.research.google.com

Reto 1:

That’s a lot of money

Reto 2:

And a lot of users

Reto 3:

Total success!

5.
Aplicación

Un ejemplo aplicado a través de un servicio

Servicio web

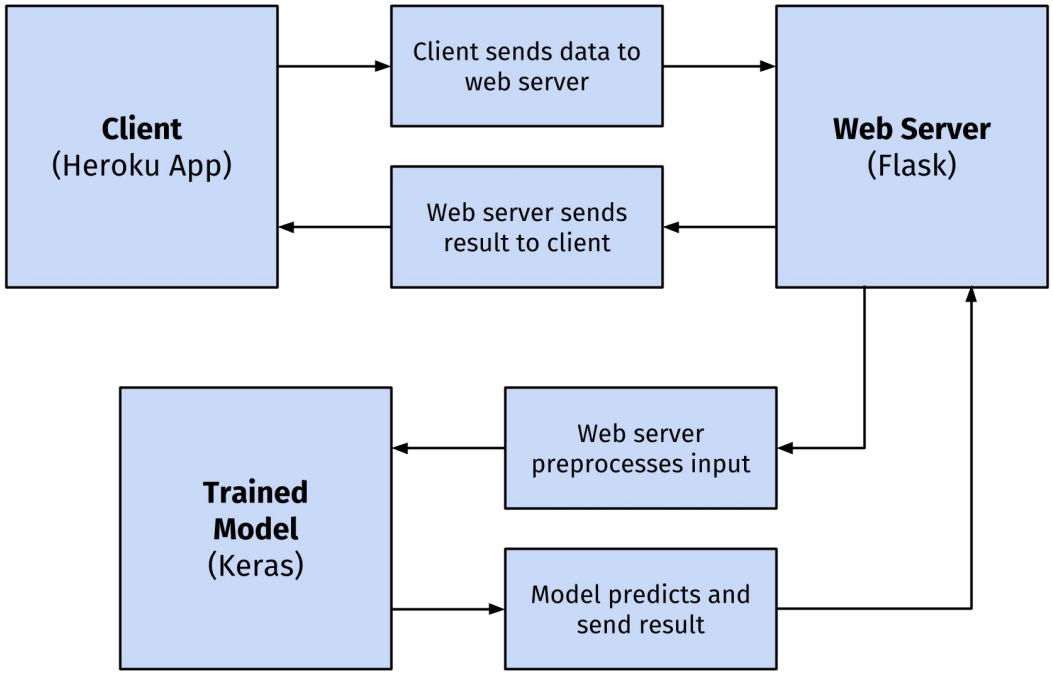
Un ejemplo sencillo de aplicación directa para clasificación de dígitos escritos a mano.

URL:

https://kerasmnist.herokuapp.com/

https://github.com/RodolfoFerro/KerasMNIST

Sobre el servicio...



¡Gracias!

¿Preguntas?

Encuéntrame:

@FerroRodolfo

@rodo_ferro

https://rodolfoferro.xyz/