



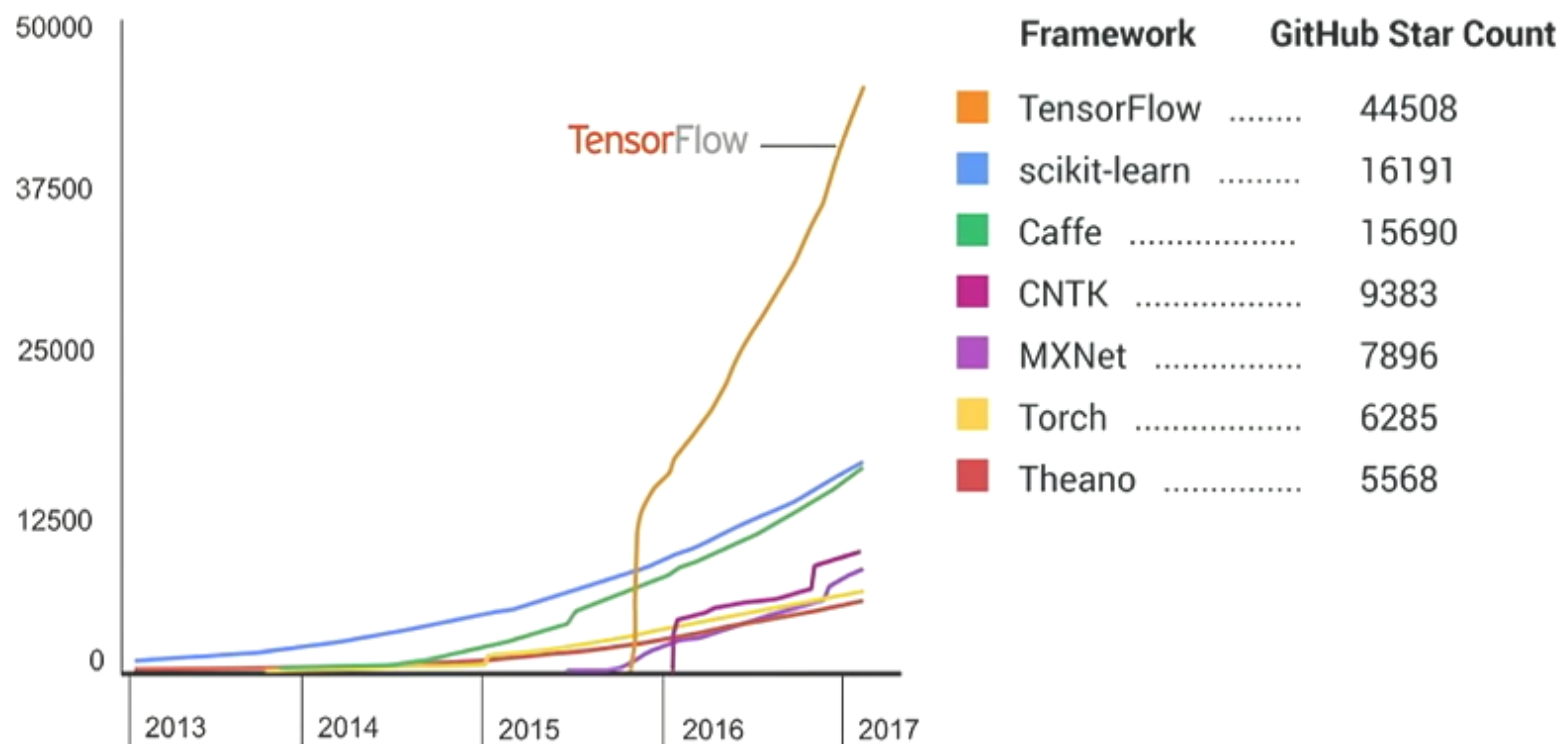
Introduction to TensorFlow

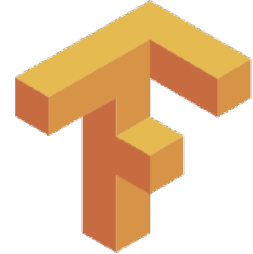
https://www.tensorflow.org/get_started/get_started
<https://www.tensorflow.org/tutorials/>



Why TensorFlow?

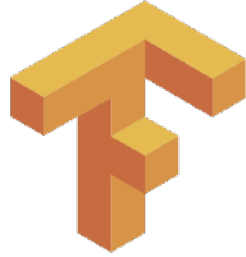
- Has the largest user community
- Well documented
- Most popular Deep Learning framework





What is TensorFlow?

- A Deep Learning library open-sourced by Google Brain
- Provides primitives for defining functions on **tensors** and automatically computing forward outcomes and backward derivatives
- Designed for neural computation using data **flow** graphs



What is a Tensor?

Tensor = n -dimensional matrix

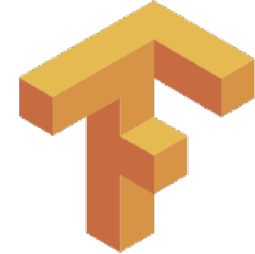
A tensor can be:

a scalar

a vector

a matrix

$$T = \begin{array}{|c|} \hline \begin{array}{cccc} X_{111} & X_{112} & X_{113} & \dots & X_{11N} \\ X_{121} & X_{122} & X_{123} & \dots & X_{12N} \\ X_{131} & X_{132} & X_{133} & \dots & X_{13N} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ X_{N11} & X_{N12} & X_{N13} & \dots & X_{N1N} \end{array} \\ \hline \end{array}$$



What is a Data Flow Graph?

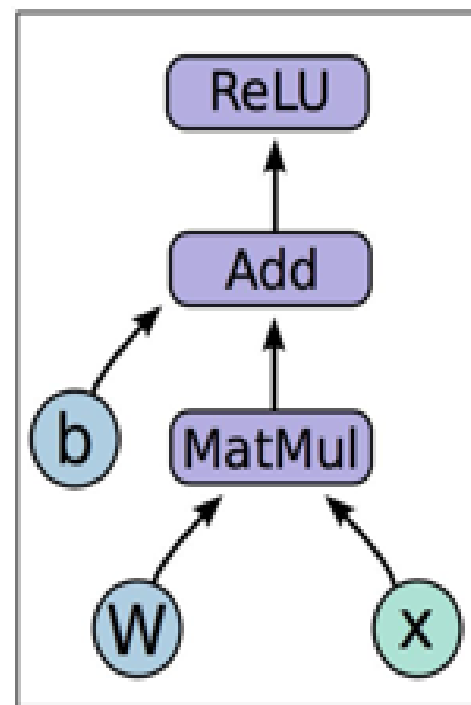
- Computations are represented as **graphs**:

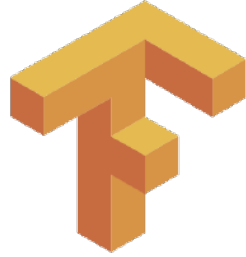
- Nodes are the operations (ops)
- Edges are the Tensors

$$h = \text{ReLU}(Wx + b)$$

- Typical program consists of 2 phases:

- **Construction** phase:
Assembling a graph (a model)
- **Execution** phase:
Pushing data through the graph

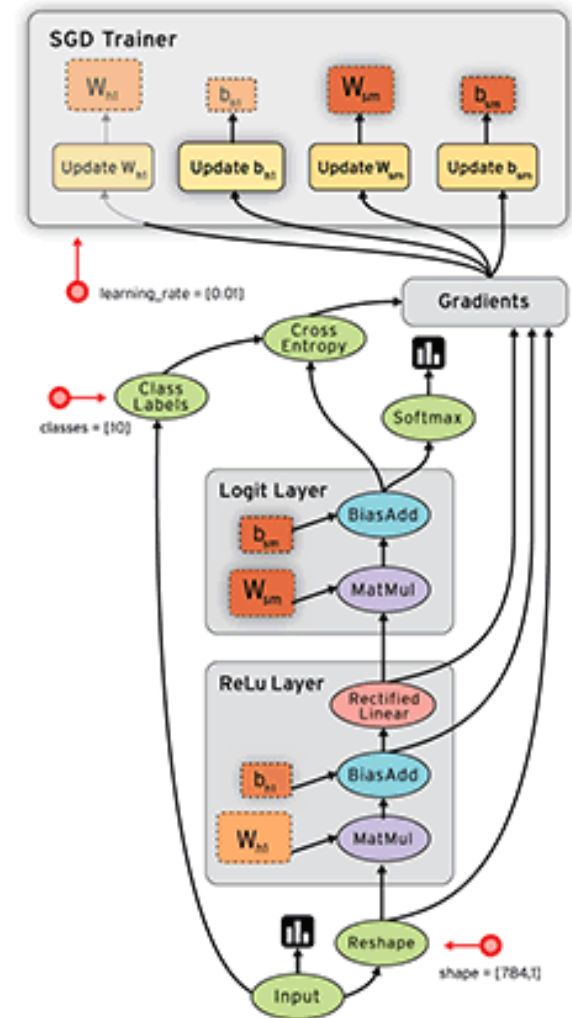


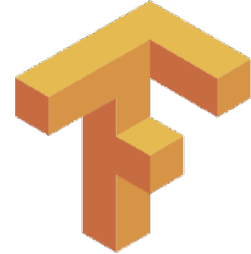


An Example of Data Flow Graph

A two layers Neural Network

- Input: X
- First layer:
$$H = \text{ReLU}(W1 * X + b1)$$
- Second layer:
$$O = \text{Softmax}(W2 * H + b2)$$

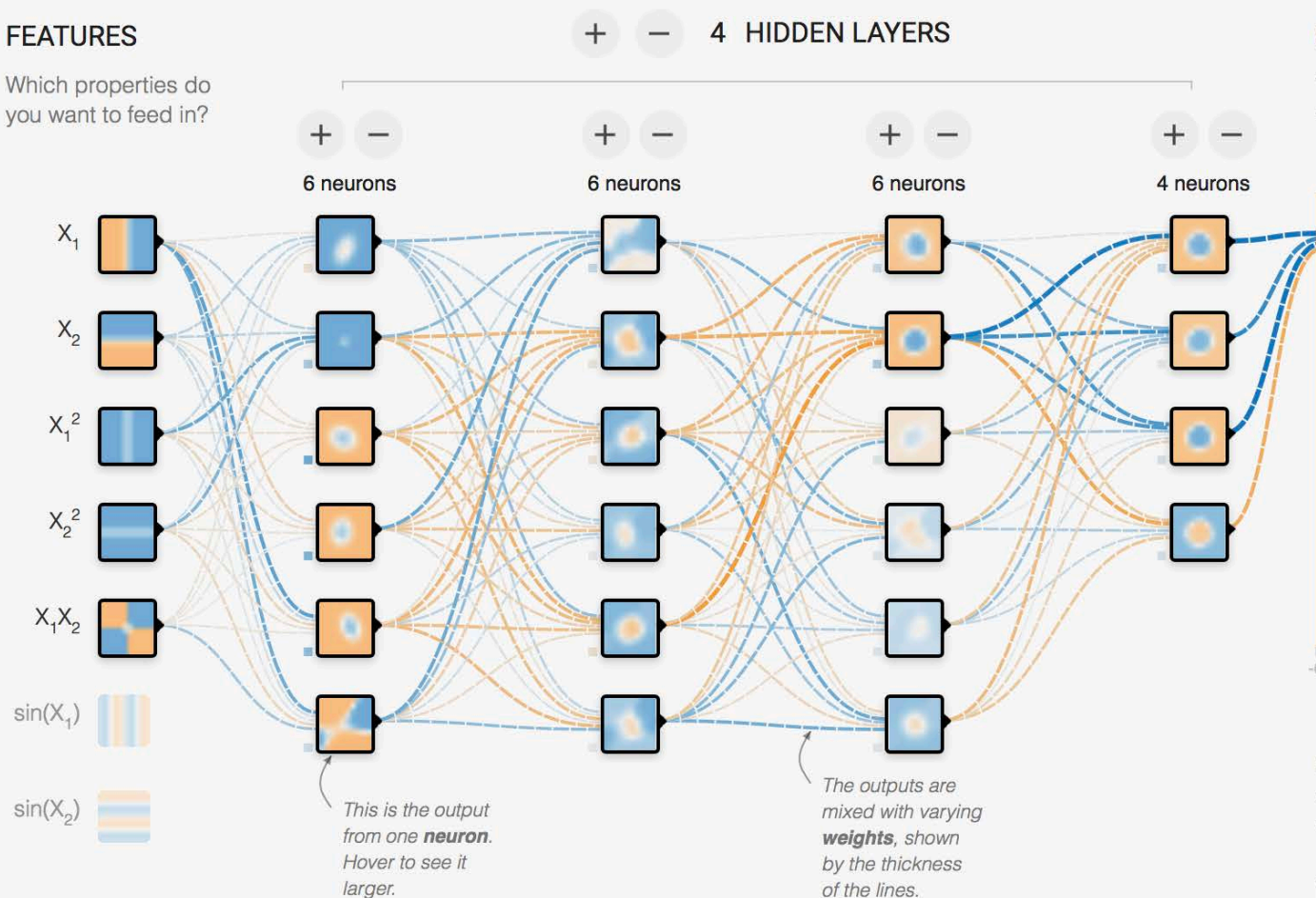




An Example of Data Flow Graph

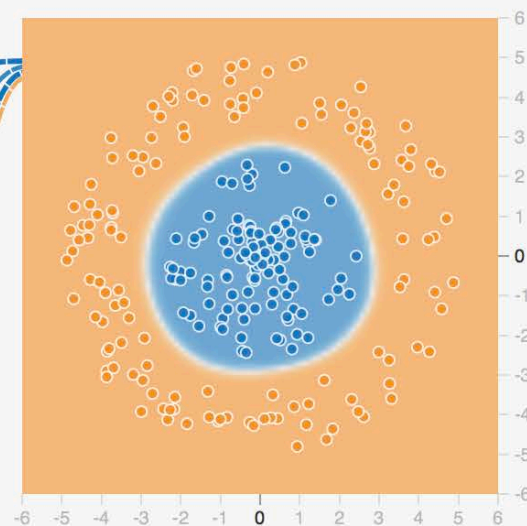
FEATURES

Which properties do you want to feed in?

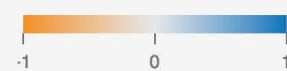


OUTPUT

Test loss 0.000
Training loss 0.000

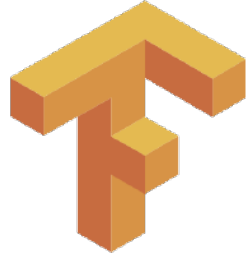


Colors shows
data, neuron and
weight values.



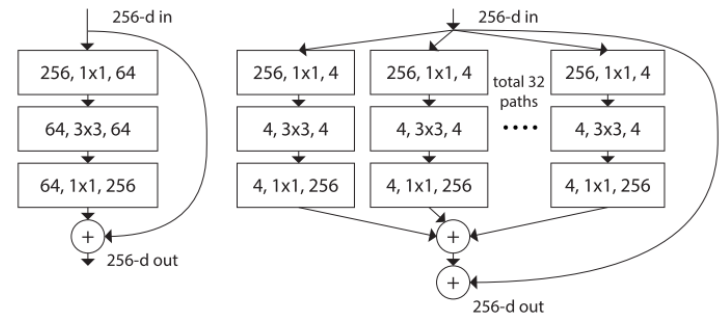
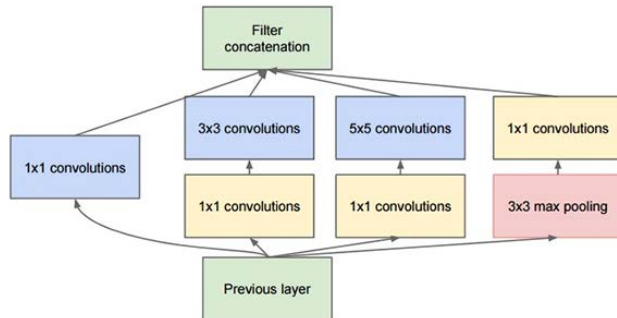
☐ Show test data ☐ Discretize output

Tensorflow playground: <http://playground.tensorflow.org/>

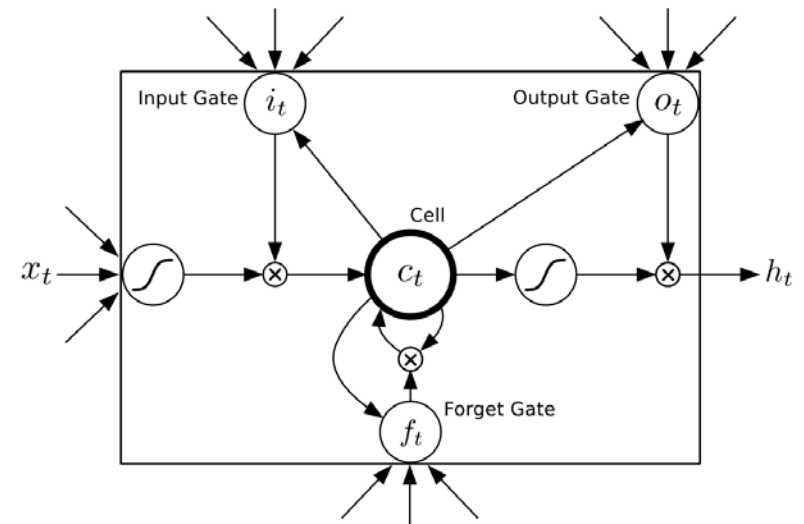
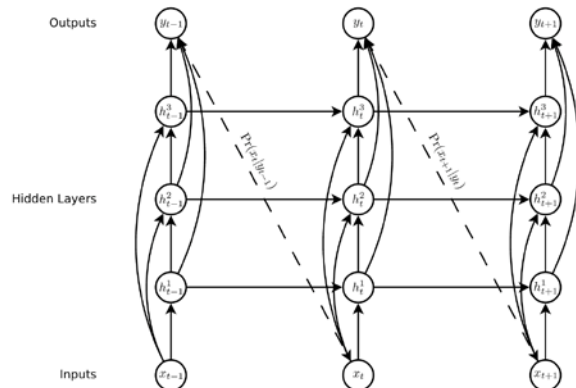


Why use TensorFlow?

- Flexibility of designing & testing complex network structures:
 - CNNs (Inceptions, ResNets,)



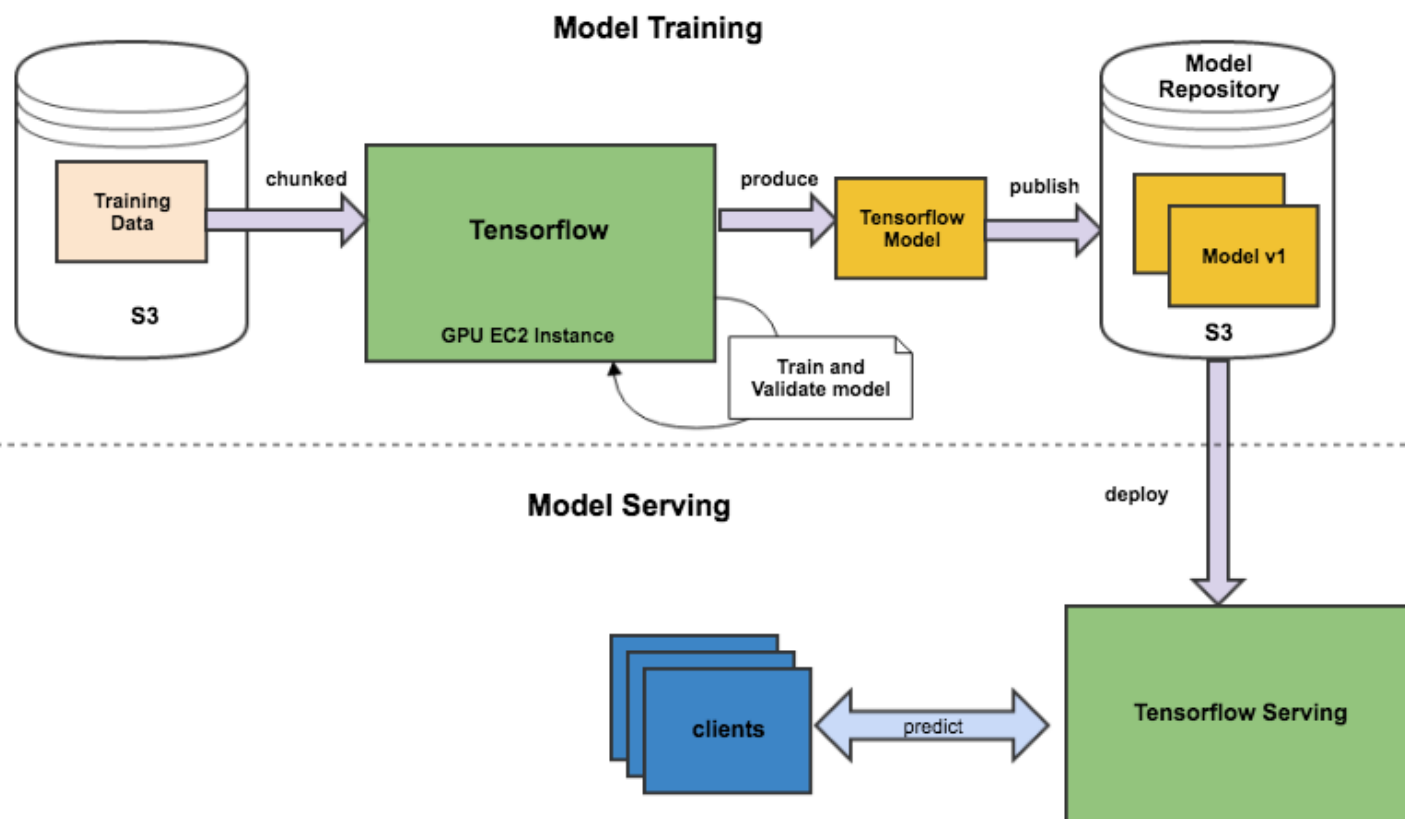
- RNNs (LSTMs, GRU,)

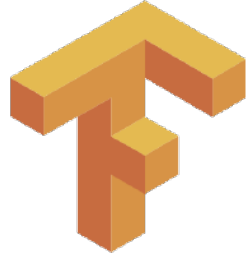




Why use TensorFlow?

- Seamless transition from model training to deployment:





Why use TensorFlow?

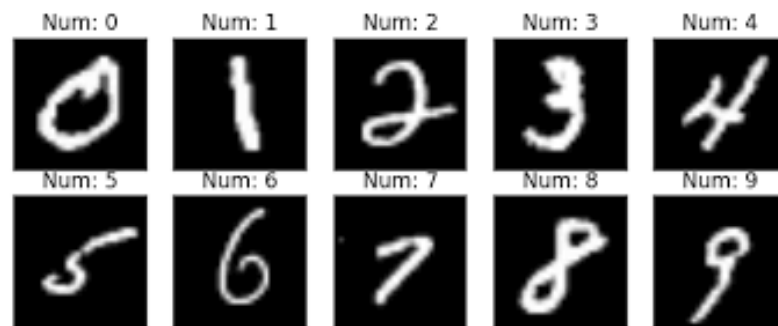
- Other benefits:
 - ✓ More stable API,
 - ✓ Better documentation and more advanced tools,
 - ✓ Runs on clouds, mobiles, desktops, ...

Week 3 Tutorial: An Exercise about Using TensorFlow with a Model

- Use the TensorFlow environment to construct and train a deep learning neural network (train), and then use this model for deployment (test).

Dataset: MNIST (Modified National Institute of Standards and Technology database)

- What is MNIST?
 - A dataset for handwritten digits.
 - It has a training set of 60,000 examples, and a test set of 10,000 examples
 - Modified from the NIST original black-white binary images to normalised grey-level images for domain transfer learning



<http://yann.lecun.com/exdb/mnist/>



References

[LeCun et al., 1998a]

Y. LeCun, L. Bottou, Y. Bengio, and P. Haffner. "Gradient-based learning applied to document recognition." Proceedings of the IEEE, 86(11):2278-2324, November 1998.

Why MNIST?

- MNIST is a good database for learning techniques and introducing to pattern recognition methods on real-world data with minimal efforts on preprocessing and data formatting.
- Small pixels and fast computing (quick results in getting feedback)
 - ❖ 28*28 pixels
- Large size dataset for images and labels:
 - ❖ 60,000 for training
 - ❖ 10,000 for testing
- Less noise & highly differentiated classes
 - ❖ 10 classes (0-9)

