Dynamically Learning and Performing Multiple Non-Observable Tasks with a Neural Network

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Abstract

Artificial neural networks (ANNs) are universal function/task approximators. Multi-task learning refers to ANNs that can approximate multiple functions/tasks. Multi-task learning has traditionally been done in fully observable environments. Previously, we created a novel context layer in the Python framework Keras to simplify building ANNs for use in non-observable environments. We built a training approach that uses a context switching algorithm that allows a neural network using the novel context layer to autonomously switch between its contexts to perform multi-task supervised learning (supervised n-task learning) and learn 8 non-observable logic gate type tasks mapped to its 8 different contexts. We are currently working on the testing approach

Background

- ANNs are mathematical models inspired by the human brain. To simplify the computer programming of ANNs, libraries such as TensorFlow [1] and Keras [2] have gained much traction in recent years.
- To better model the way that the brain works on multiple tasks, n-task learning was created to allow multi-task reinforcement learning for ANNs. [3]
- ANNs capable of n-task learning were previously difficult to implement, and no training and testing regimen existed for supervised n-task learning.
- ANNs in a fully observable environment have all info necessary available to complete a task ex. Chess. In contrast, a non-observable environment gives no info necessary to complete a task ex. for an ANN, the task has switched, but the input looks the same.
- Logic gates are basic binary logic operations. They are commonly used in circuits and computer programming. Given two inputs, a logic gate produces a single output. The set of possible inputs is the same for every logic gate.

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Task Switching in Context Layer

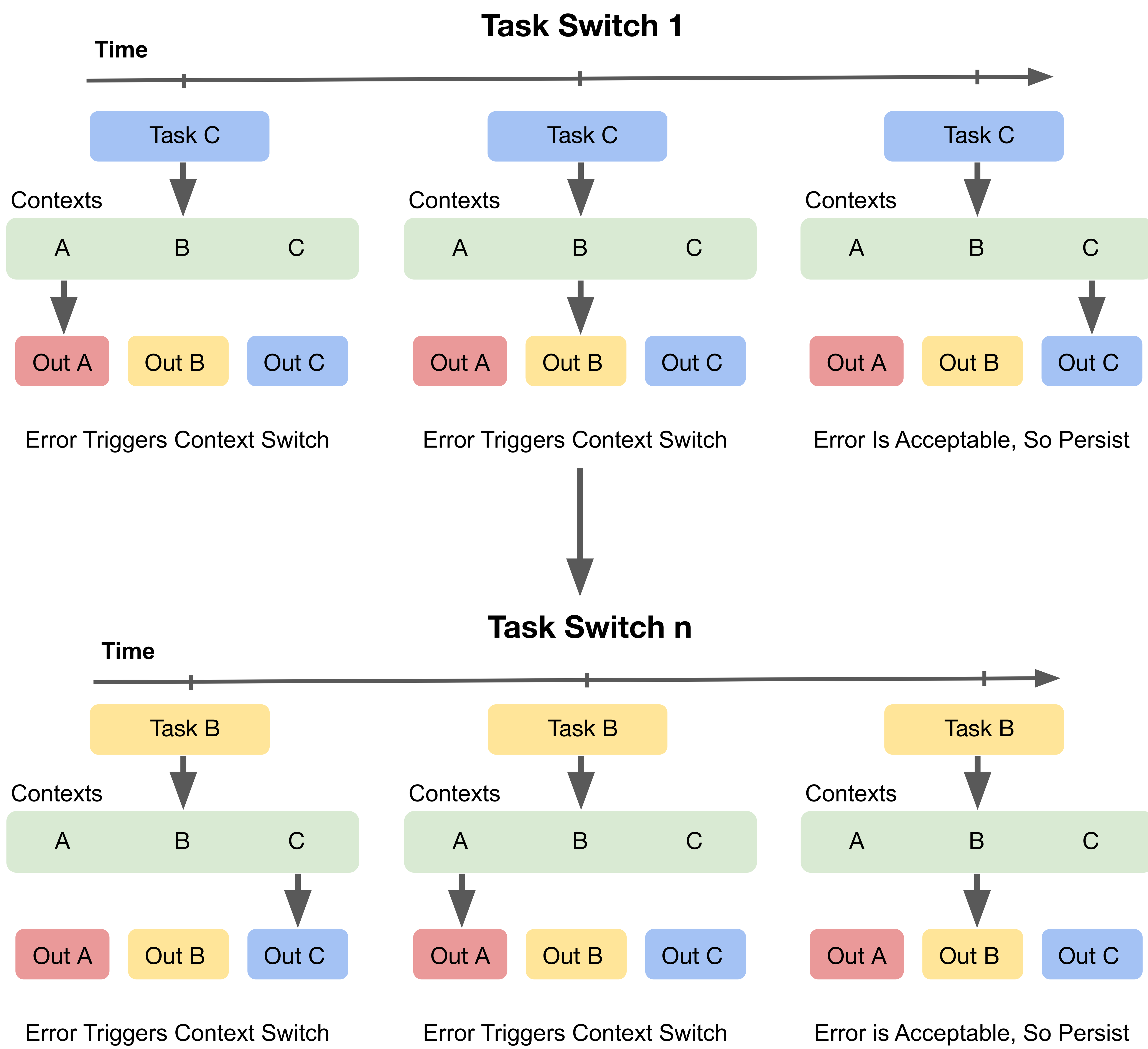

Figure 1: Example of context switching behavior during training and/or testing with a neural network for n task switches. For Task ε, the expected output is Out ε. The matching context would need to be context ε to produce the expected output. If the error is unacceptable, the context will automatically switch.

Training Approach

A looping process of randomly selecting a task and staying on the task for a set number of epochs. The model cycles through its contexts to find its best-fitting context and then learns the task on this context. Learning never occurs for a trial that results in a context switch.

Testing Approach

The testing approach is in progress and is similar to the training approach, however the model doesn't learn—it only predicts.

Objectives

To allow neural networks to learn multiple non-observable logic gate type tasks autonomously as tasks switch.

Results

The novel context layer and training approach are completed. The testing approach is nearing completion.

Discussion / Future

- Complete the testing approach and get full results for the logic gate experiment.
- Repeat experiment using more difficult data and tasks—multiple non-observable handwritten digit recognition tasks.

References

[1] Abadi, Martín, Ashish Agarwal, Paul Barham, Eugene Brevdo, Zhifeng Chen, Craig Citro, Greg S. Corrado et al. "Tensorflow: Large-scale machine learning on heterogeneous distributed systems." *arXiv preprint arXiv:1603.04467* (2016).

[2] Chollet, François. "Keras." (2015).

[3] Jovanovich, Michael, and Joshua Phillips. "n-task Learning: Solving Multiple or Unknown Numbers of Reinforcement Learning Problems." In *CogSci*, pp. 584-589. 2018.