Curriculum learning and experience replay in a model of a cognitive decision-making task.

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Introduction:

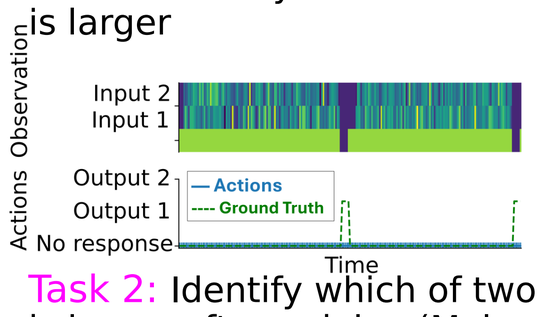
- Recurrent neural networks (RNNs) as a modeling technique in cognitive neuroscience
- Humans & networks learn faster with curriculum learning (Bengio et al. 2009)
- Sequential training can lead to catastrophic forgetting
  - Replay can alleviate this

Research Questions:

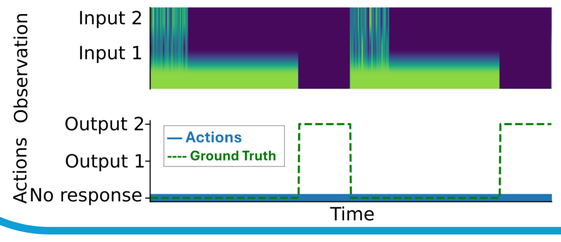
- Can RNNs learn and effectively perform multiple cognitive tasks (multitask)?
- What is the effect of training order on performance?
- What is the effect of replay on performance?

Task Descriptions:

- Task 1: Identify which of two stimuli is larger

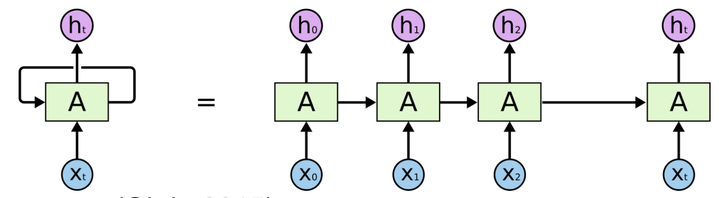


- Task 2: Identify which of two stimuli is larger after a delay (Molano et al., 2022)



Network & Training:

Long short-term memory network:



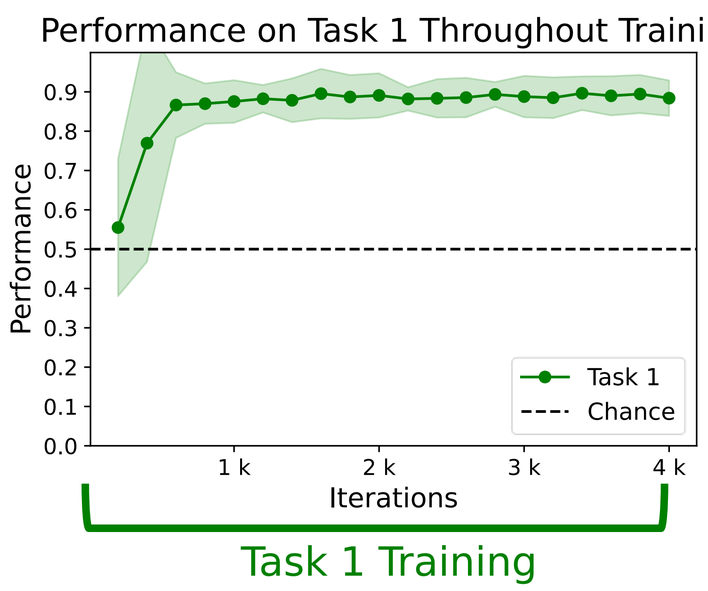
(Olah, 2015)

During **replay,** the network is trained on a batch of the previous task.

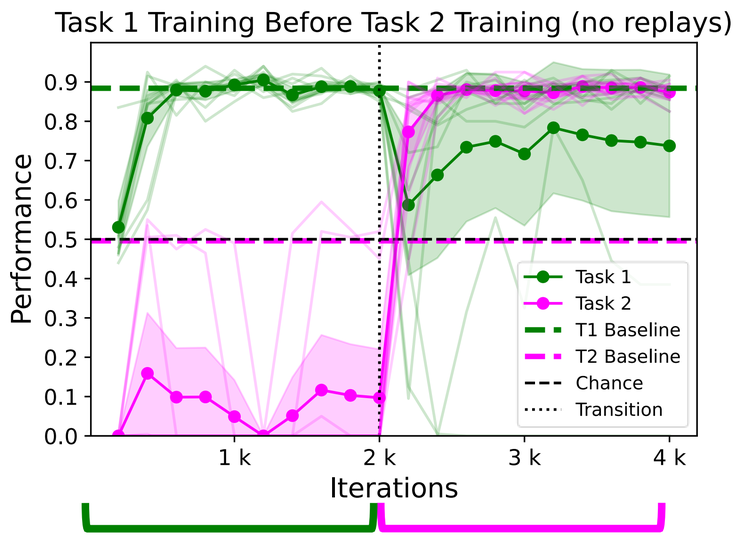
Replay of task 1: 1 2 3 4 5 6 7 8 9 10 1

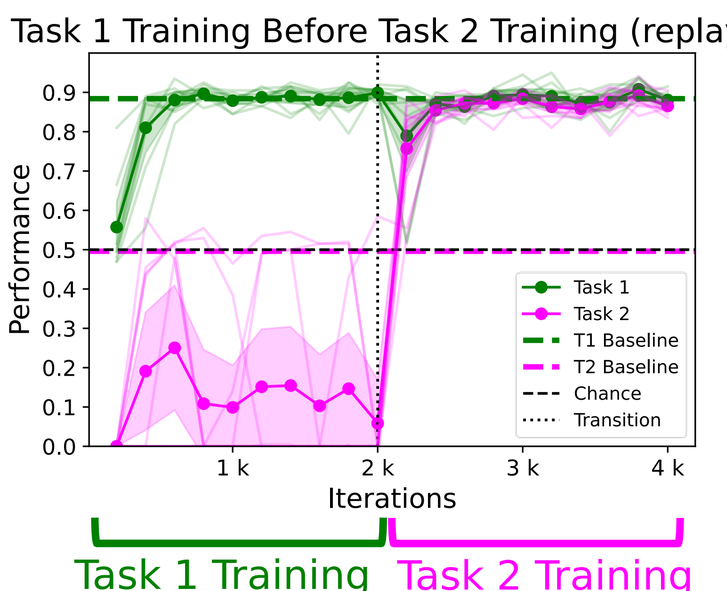
Replay of task 2: 1 2 3 4 5 6 7 8 9 10 1

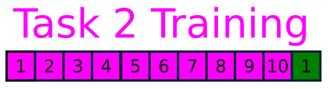
Single Task Training:



Task 1 Training Before Task 2 Training:







Task 2 Training Before Task 1 Training:

Key Findings:

- RNNs can learn and effectively perform multiple cognitive tasks.
- The RNN's performance on task 2 drastically improves when trained with task 1 (curriculum learning).
- RNNs are vulnerable to forgetting previously learned tasks (catastrophic forgetting) without replays of previous tasks.

Future Research:

- If the tasks were dissimilar, would the training order affect performance?
- Could the network maintain its performance on 3 or more tasks?

Code:

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