1. **Combining Error-driven + Hebbian**

Get benefits of both: Solve tasks, learn systematic representations, generalize to new stimuli.

What’s left?...

Time!

Currently: networks learn immediate consequence of a given input.

- What if current input only makes sense as part of a sequence of inputs (e.g., language, social interactions)?

- What if the consequence of this input comes later (e.g., school/work, life)?

2. **Sequence Learning**

How do we do it?

For example:

My favorite color is purple.
My favorite food is purple.
My favorite purple color is.

The girl picked up the pen.
The pig raced around the pen.

We represent the context, not just the current input.

in language, social interactions, driving (who should go at a 4-way stop?), etc.

3. **Representing Context for Sequence Learning**

How does the brain do it?
How would we get our models to do it?

Add layers to keep track of context (prefrontal cortex).

4. **Representing Context for Sequence Learning**

How does the brain do it?
How would we get our models to do it?
Representing Context for Sequence Learning

Simple Recurrent Network (SRN; Elman, Jordan).

\[ c_j(t) \approx h_j(t - 1) + c_j(t - 1) \]

\[ c_j(t) = f_m h_j(t - 1) + f_{prv} c_j(t - 1) \]

An Example Task

BTXSE, BPVPSE, BTSXXTVVE, BPTVPSE, BXXTTTVVE

Which of the following sequences are allowed?:

BTXXTTVVE

TSXSE

VVSXE

BSSXSE

An Example Task

BTXSE, BPVPSE, BTSXXTVVE, BPTVPSE, BXXTTTVVE

TSXSE, VVSXE, BSSXSE

We implicitly learn such grammars (e.g., pressing buttons faster to letters that follow grammar).
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