

Rethinking the Free-Time Benefit: Evidence Against a Decay and Refreshing Account

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Kowialiewski, B., & Majerus, S. (2024). Free time, sharper mind: A computational dive into working memory improvement. *Cognitive Psychology*, 155(101701). <https://doi.org/10.1016/j.cogpsych.2024.101701>

Working memory performance increases with additional time to study the list items

The “free-time benefit”

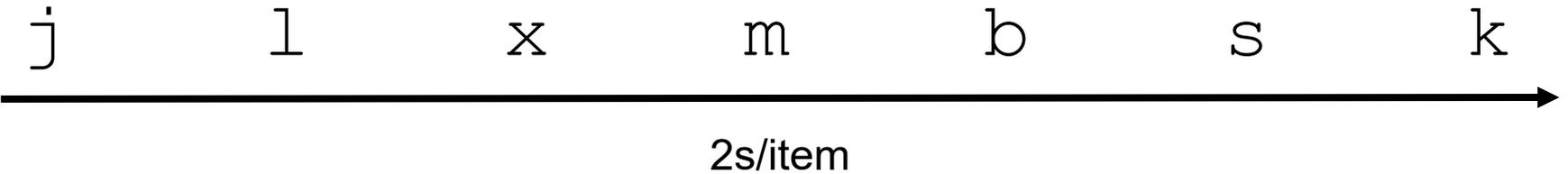
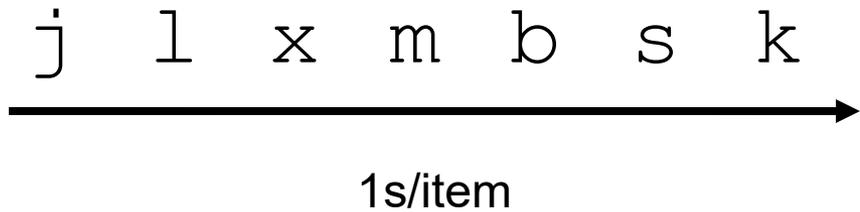
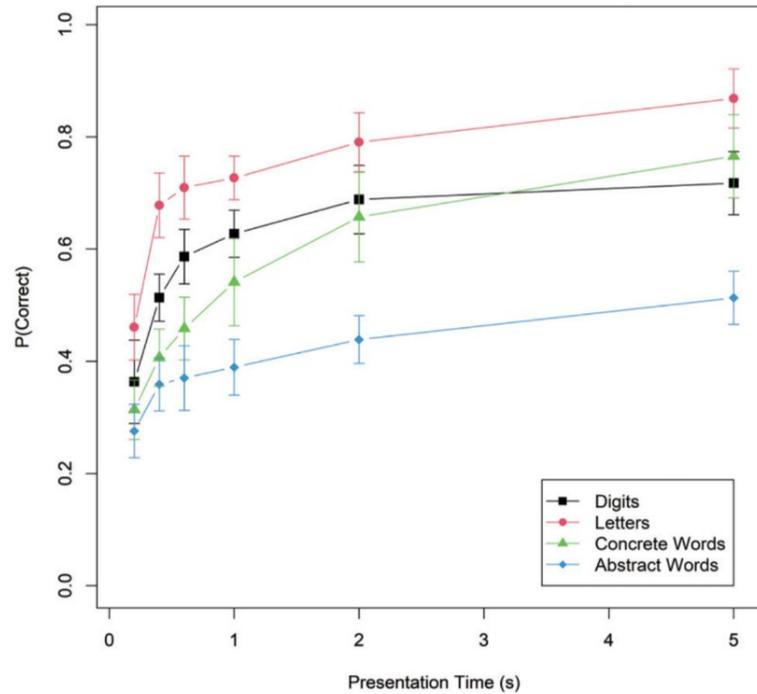
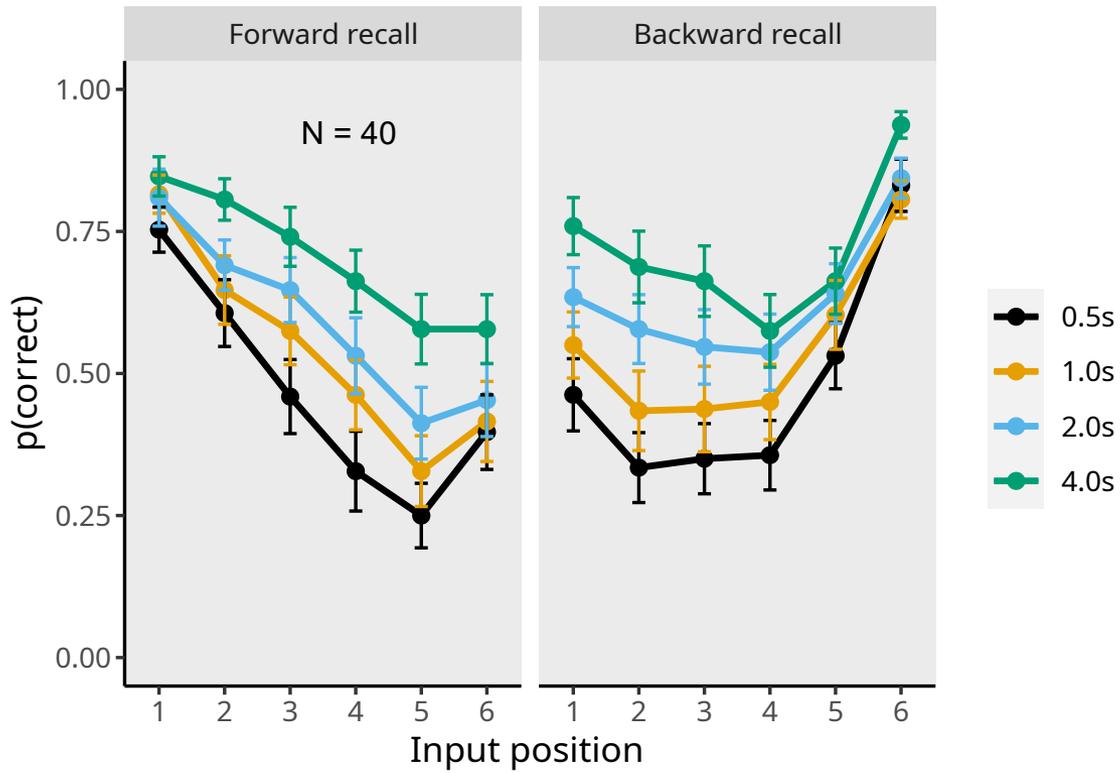
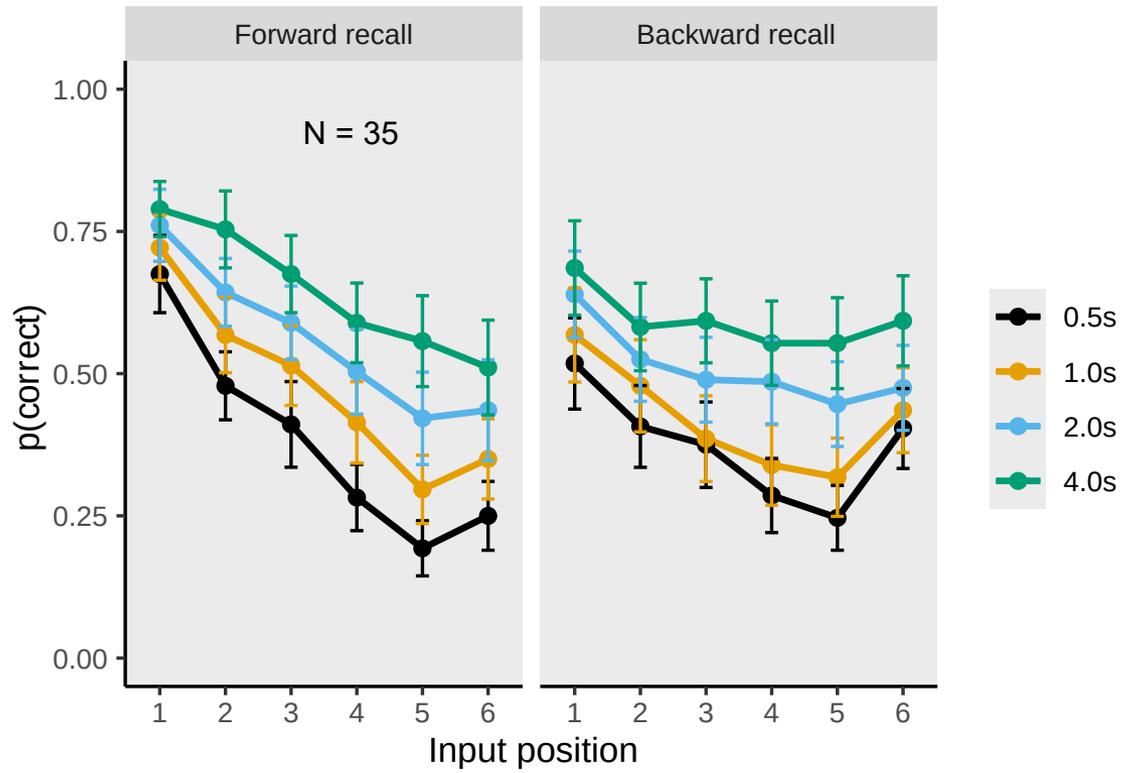


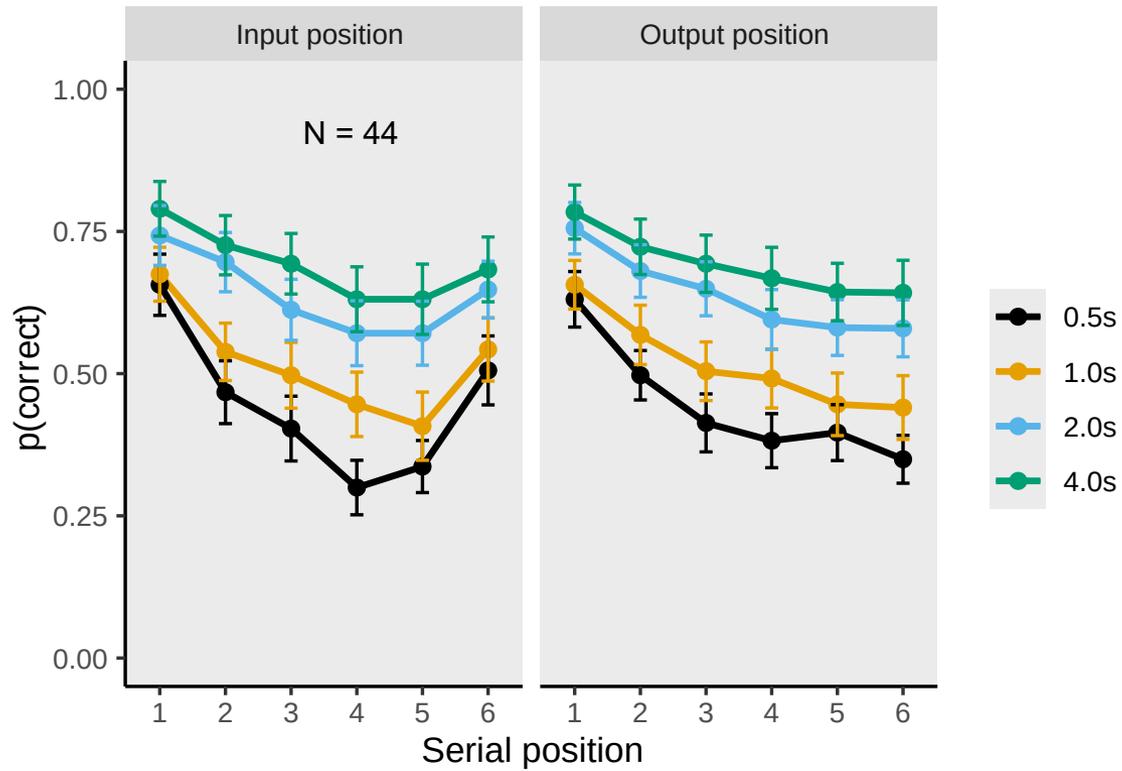
Figure 3
Time-Accuracy Plots From Experiment 1



Note. Error bars are 95% confidence intervals for within-subjects comparisons. See the online article for the color version of this figure.







Why?

Decay and **refreshing** assumptions

Baddeley and Hitch (1974)
Cowan (1995)
Baddeley and Logie (1999)
Barrouillet et al. (2004)

Decay and **refreshing** assumptions

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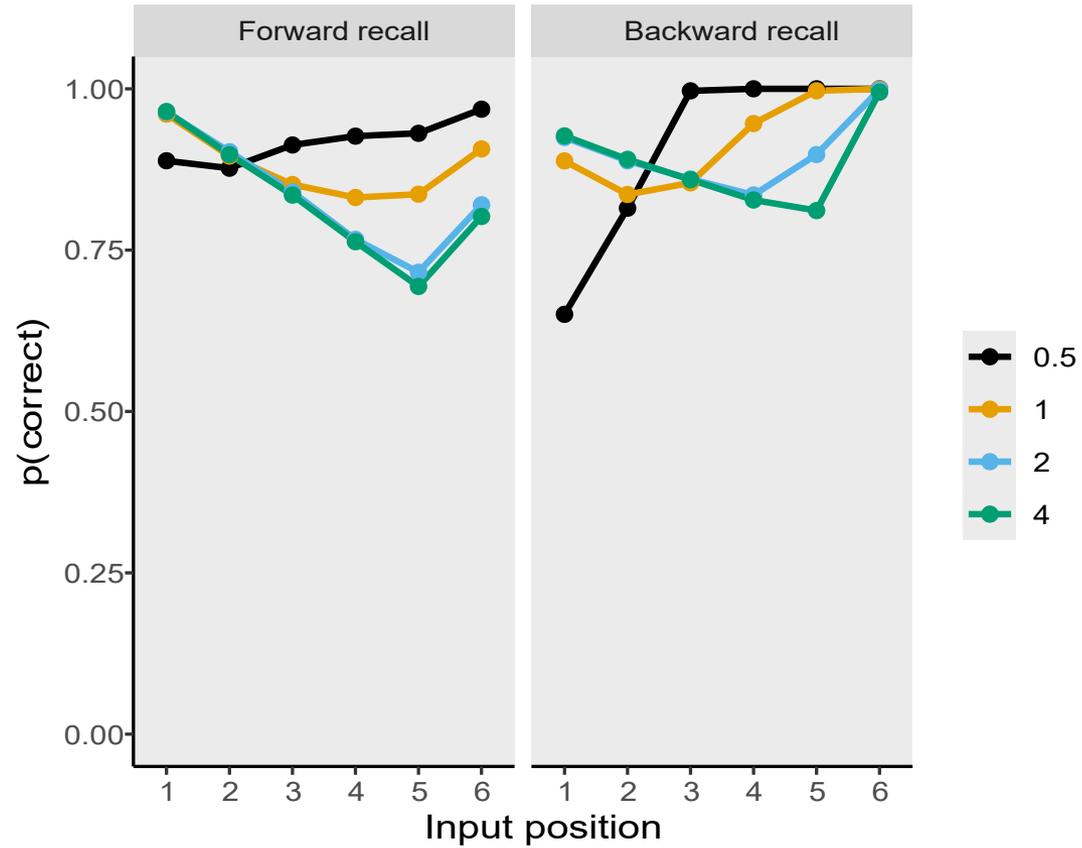
=> Additional free-time means more opportunities to counteract decay, causing a free-time benefit

Based on an **intuitive reasoning**

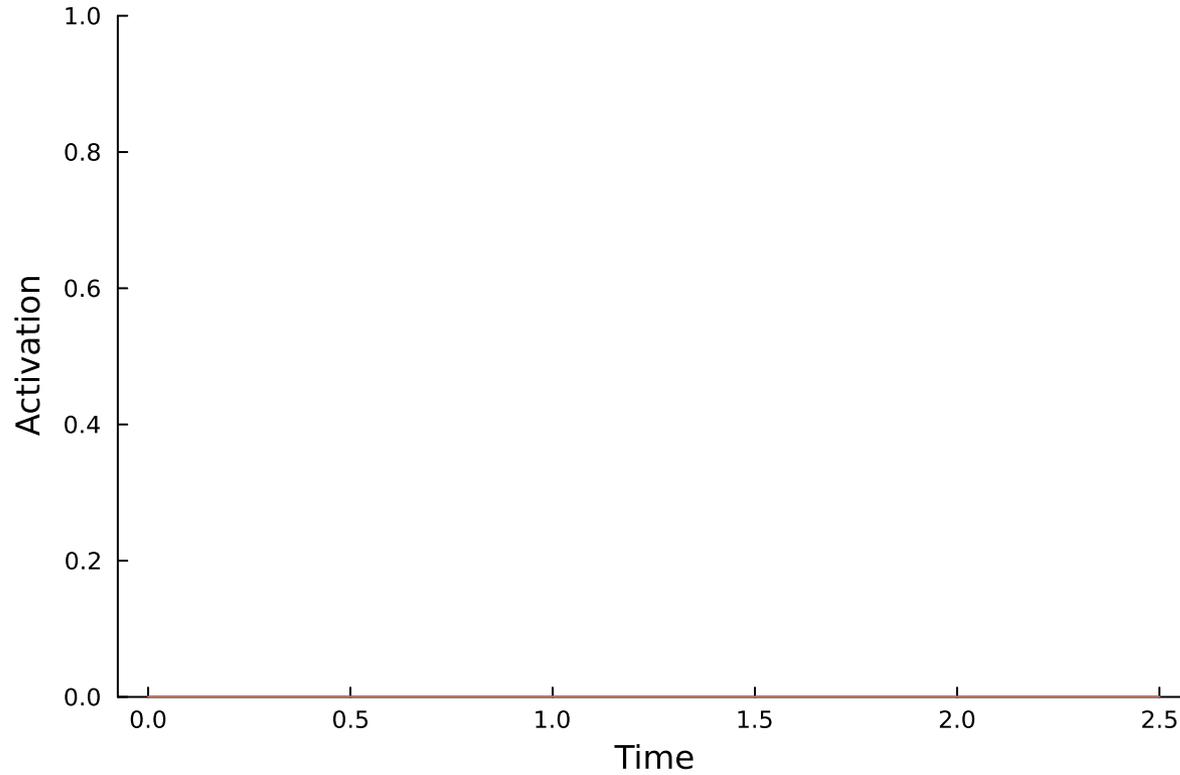
Hypothesis:

If decay and refreshing models explain the free time benefit, we should be able to simulate it by implementing these mechanisms.

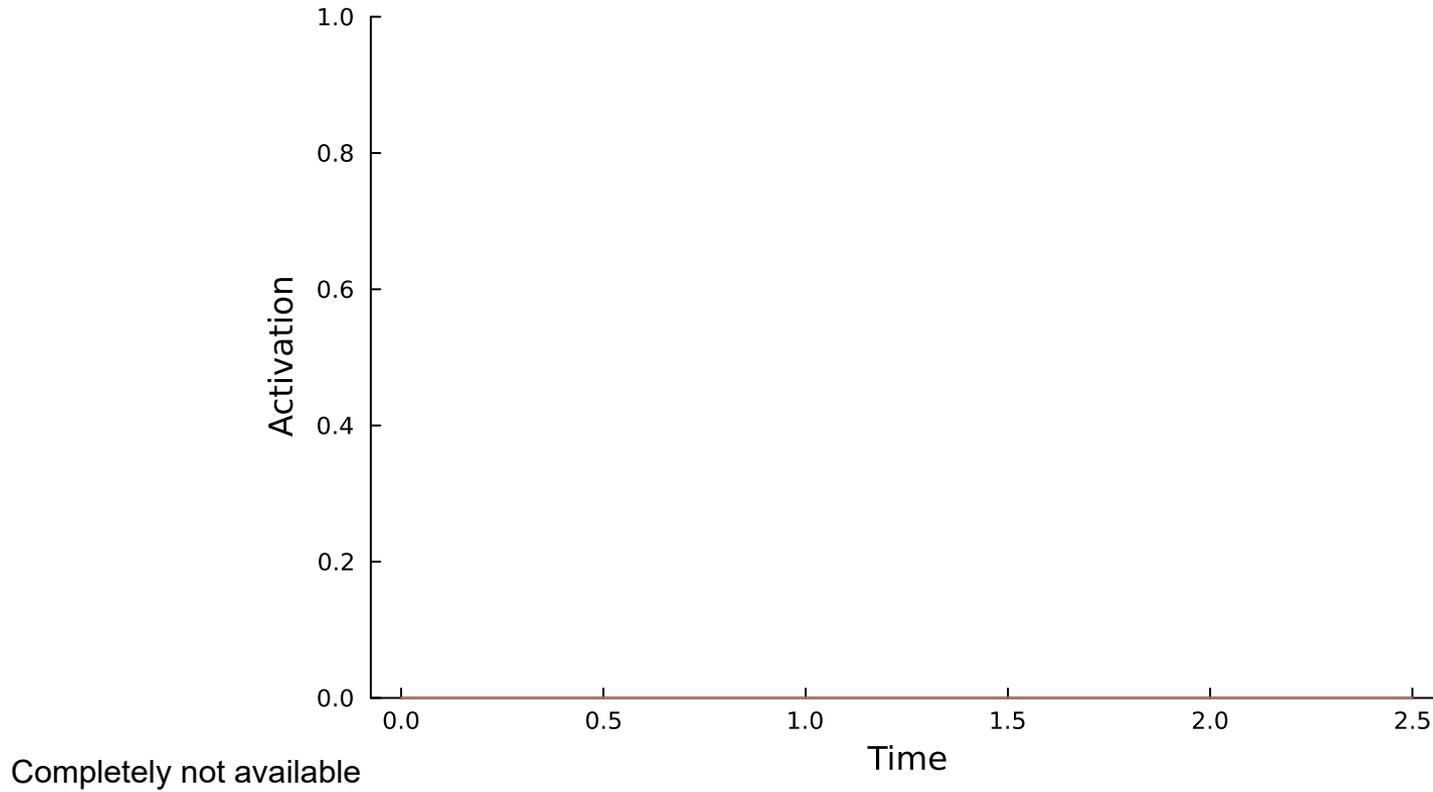
TBRS* (Oberauer & Lewandowsky, 2011, *PB&R*)



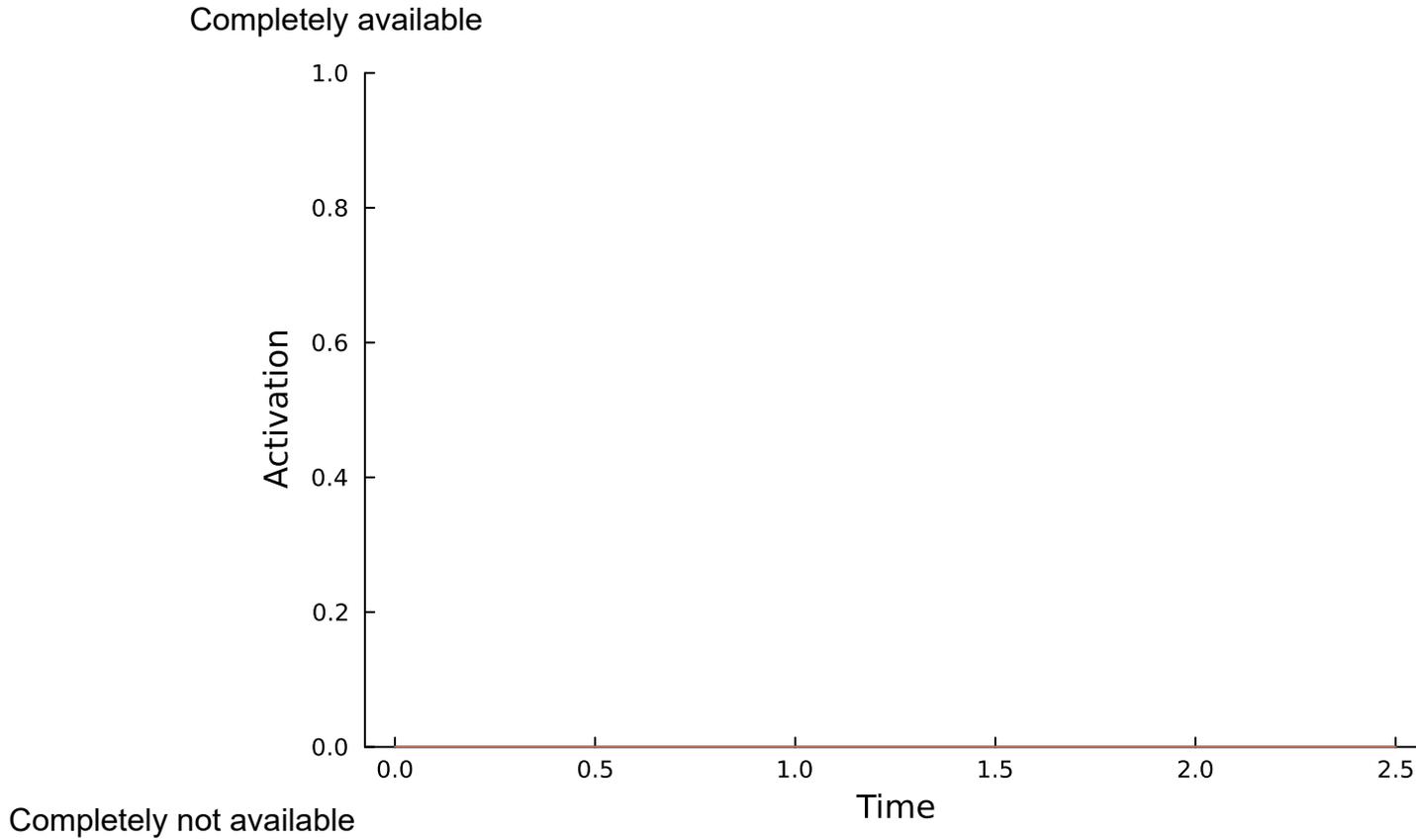
Modeling decay and refreshing



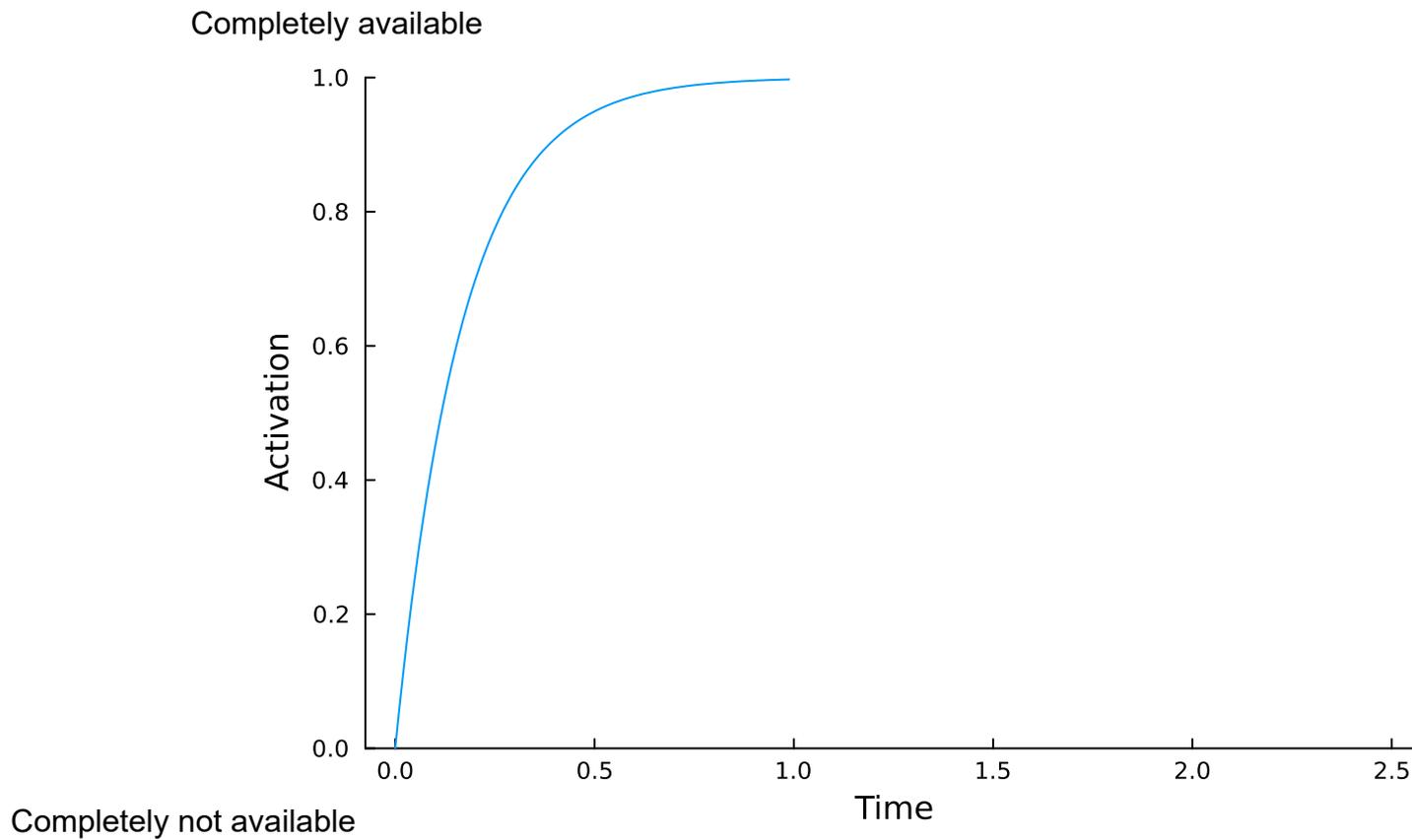
Modeling decay and refreshing



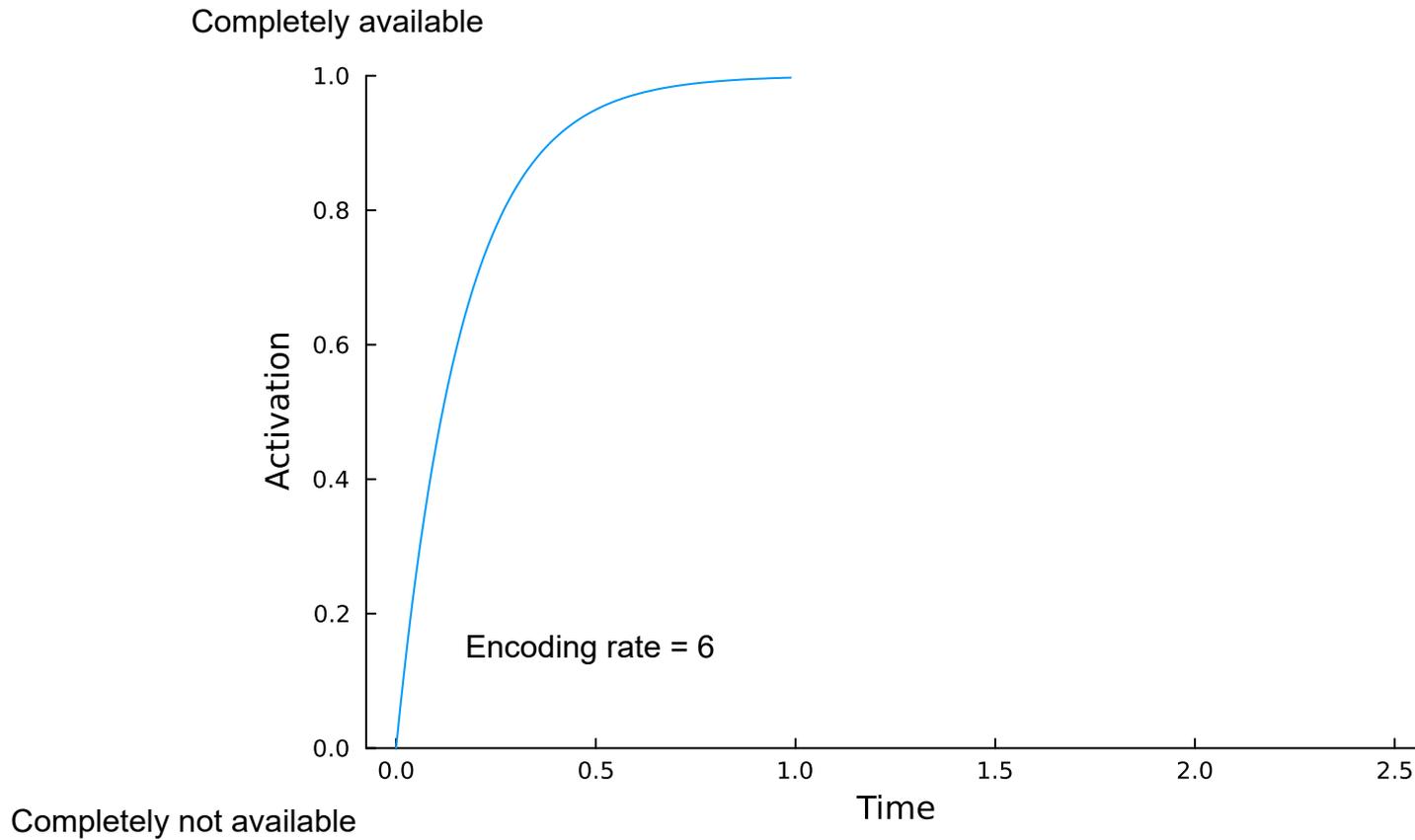
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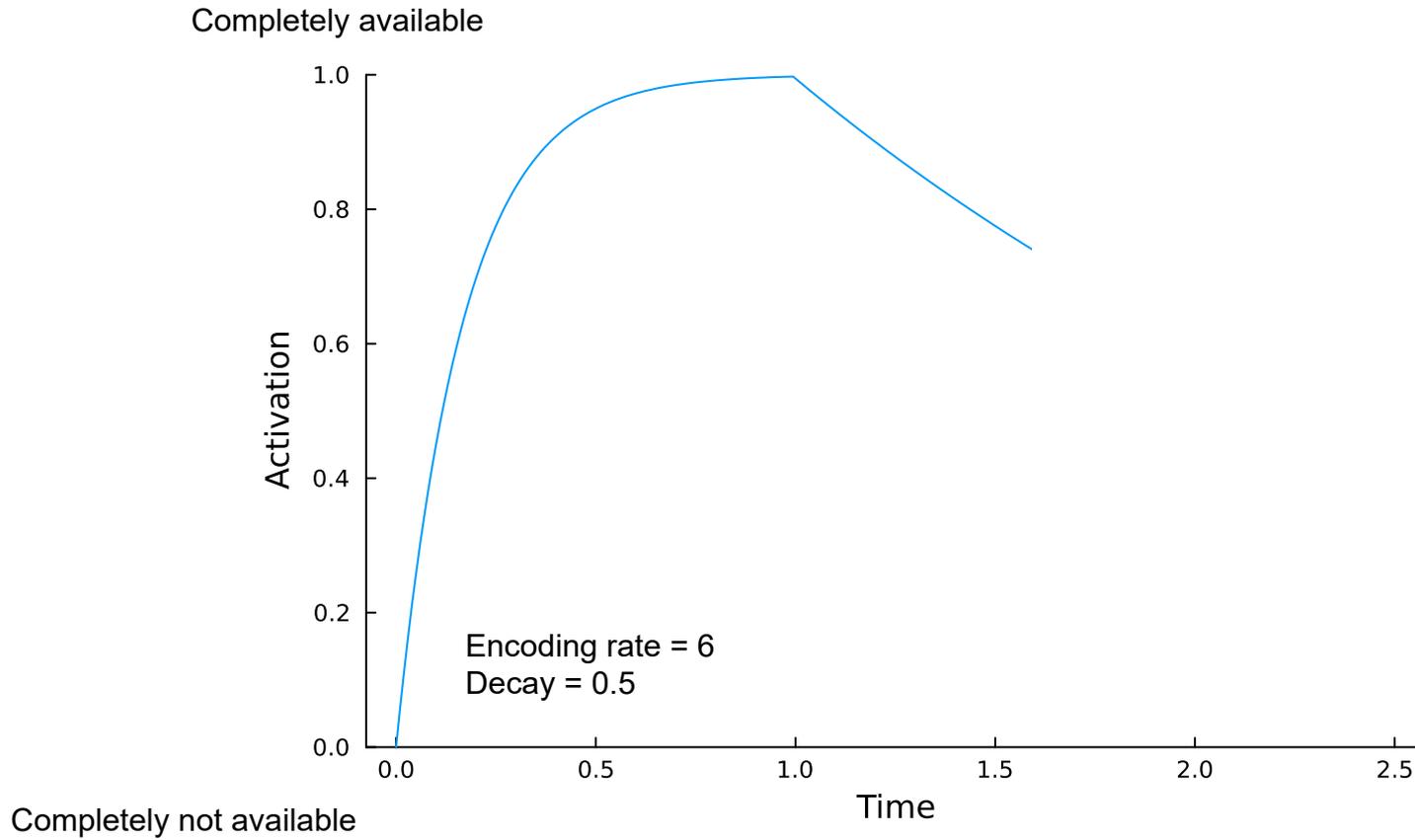
Modeling decay and refreshing



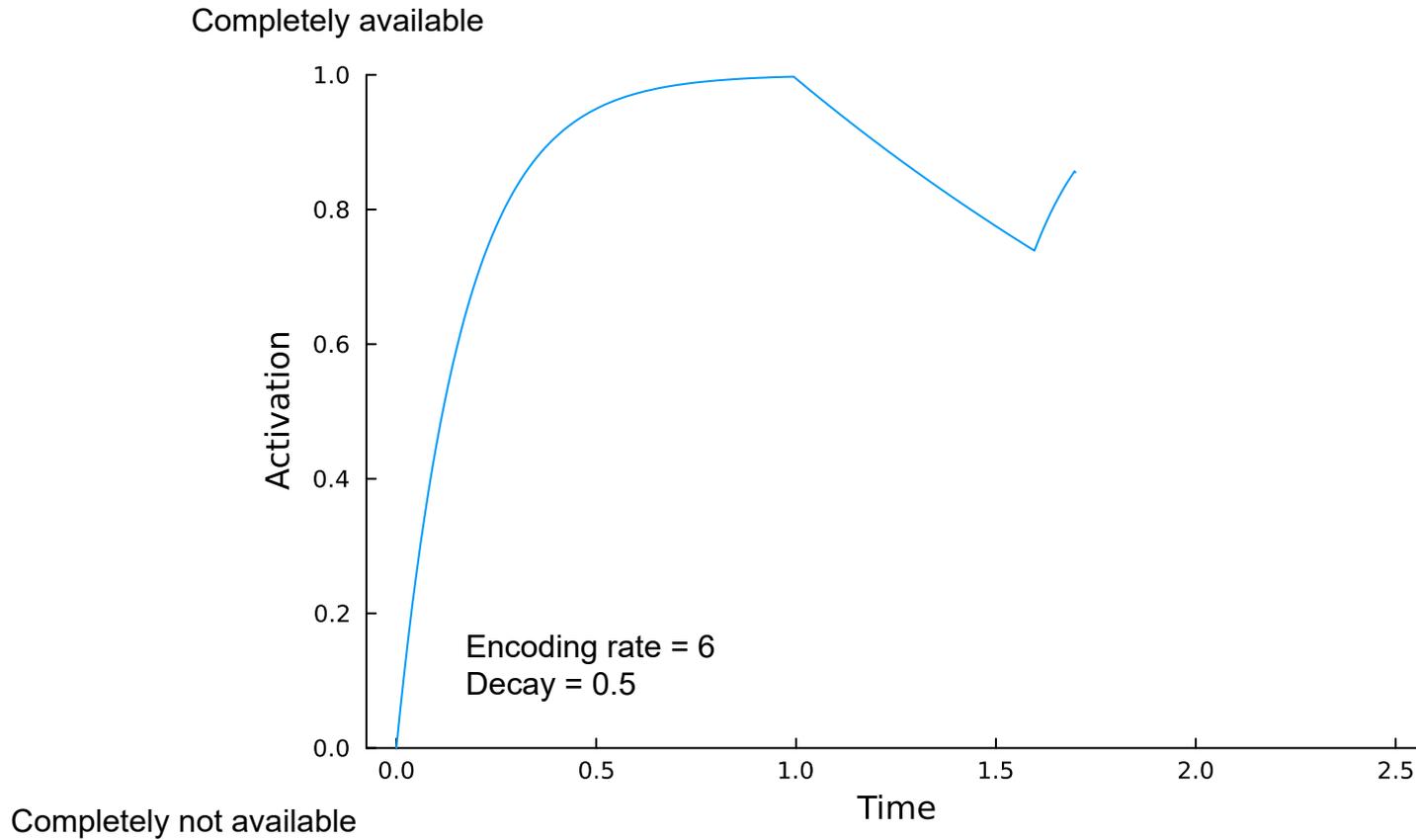
Modeling decay and refreshing



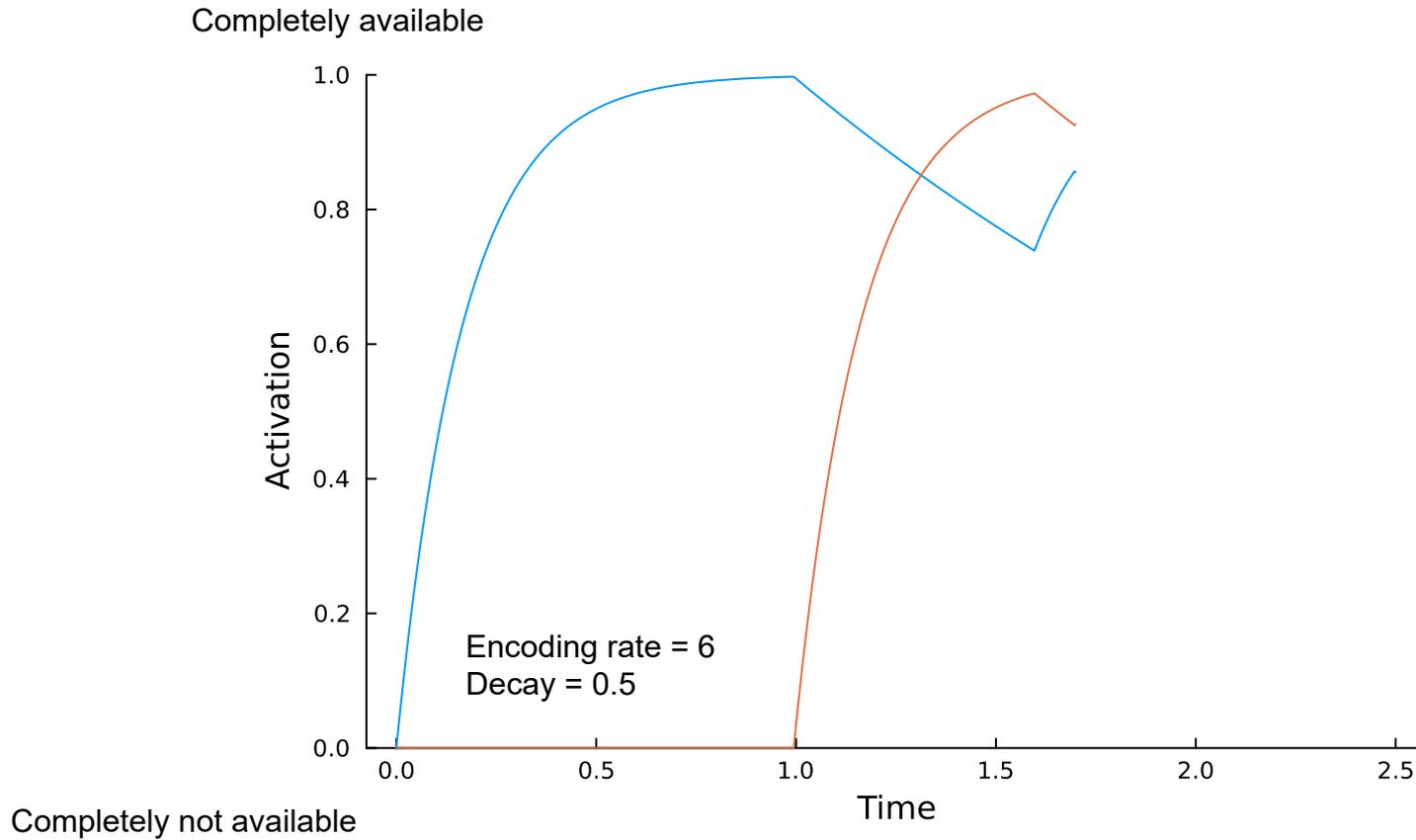
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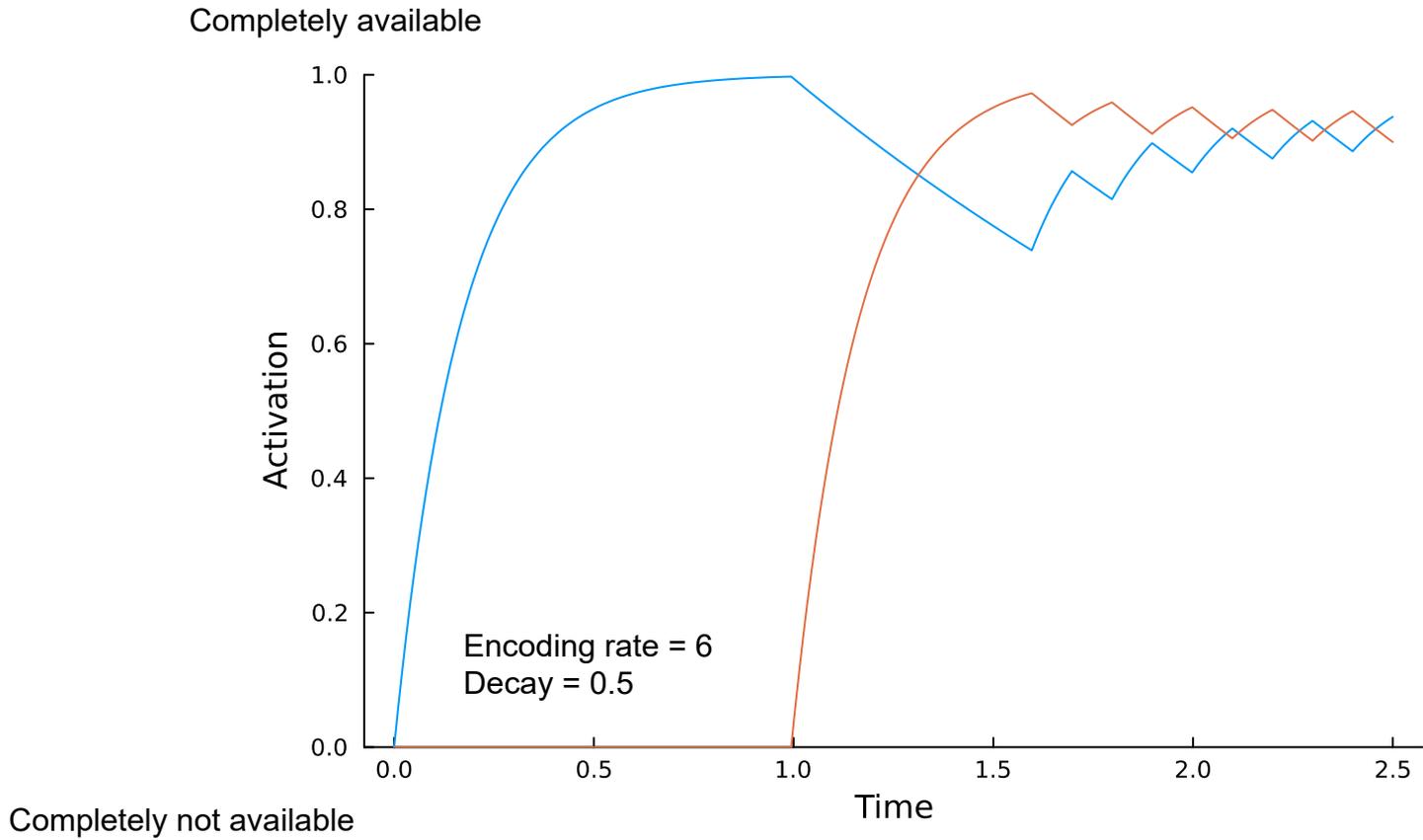
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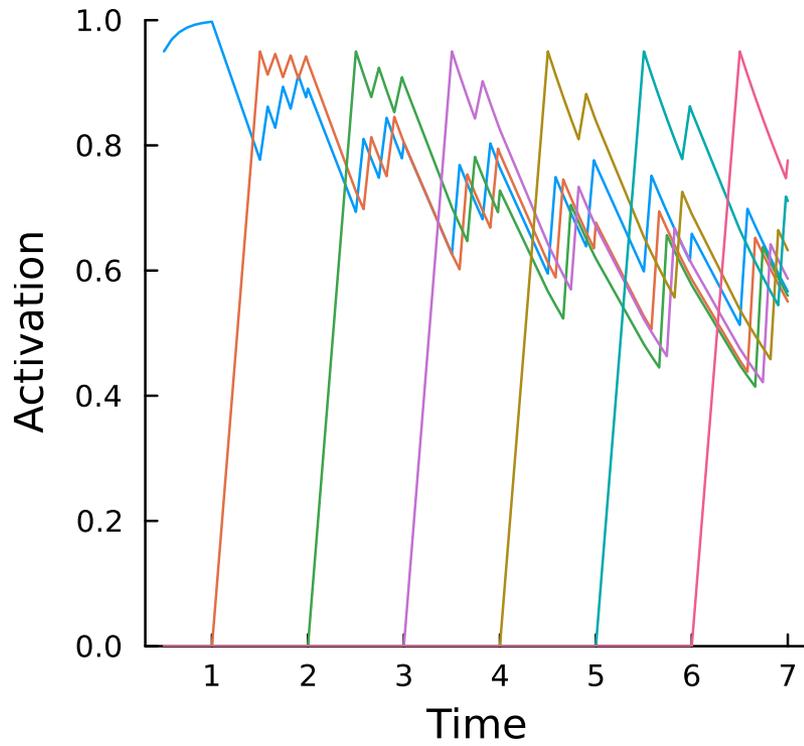
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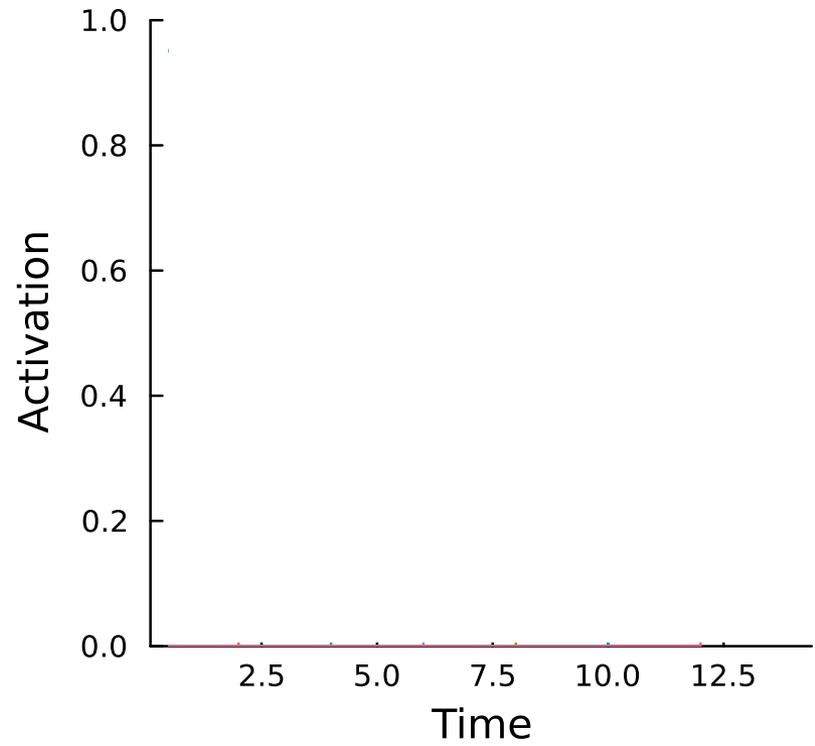


Modeling the free-time benefit



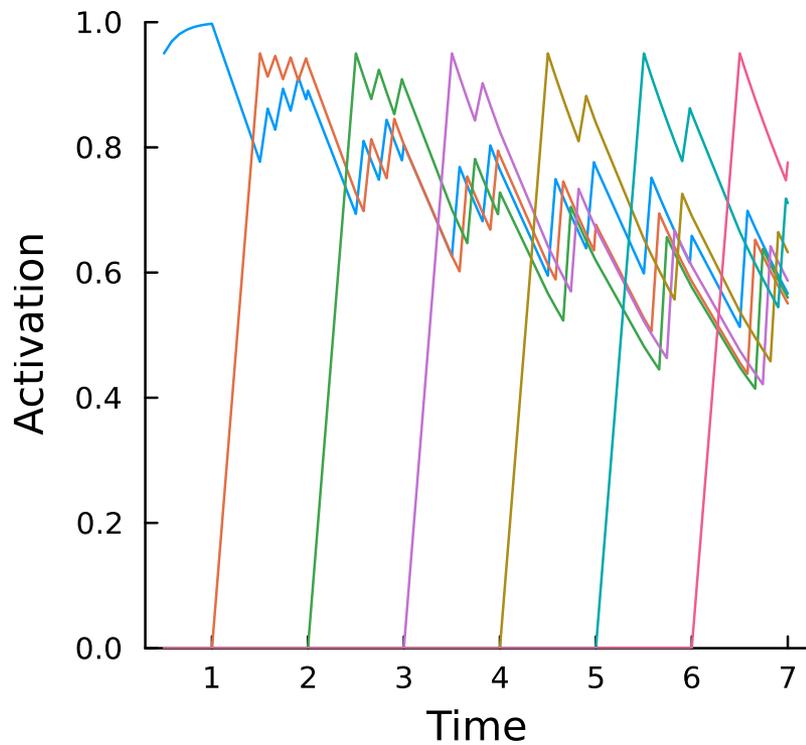
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Decay = 0.5



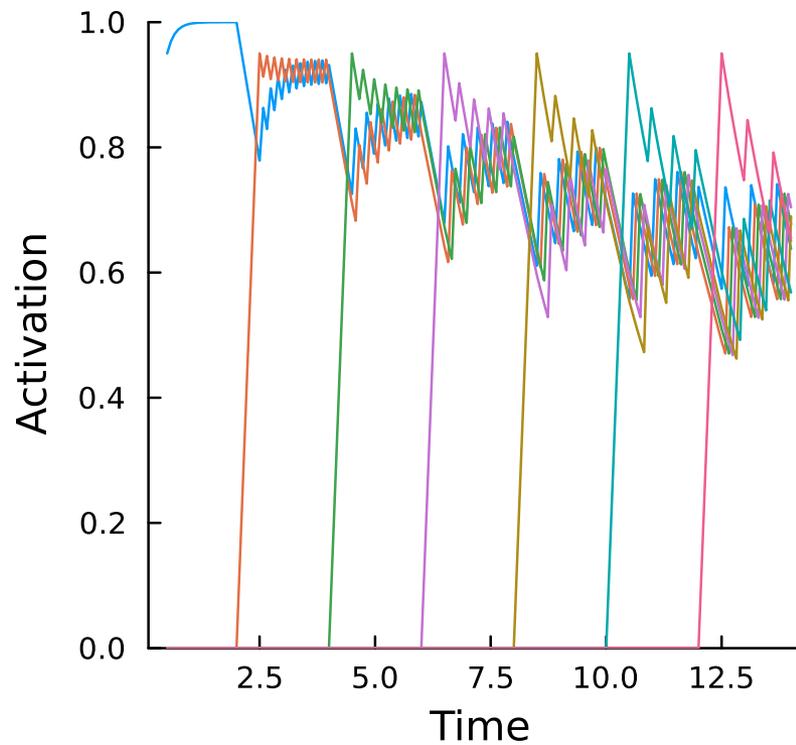
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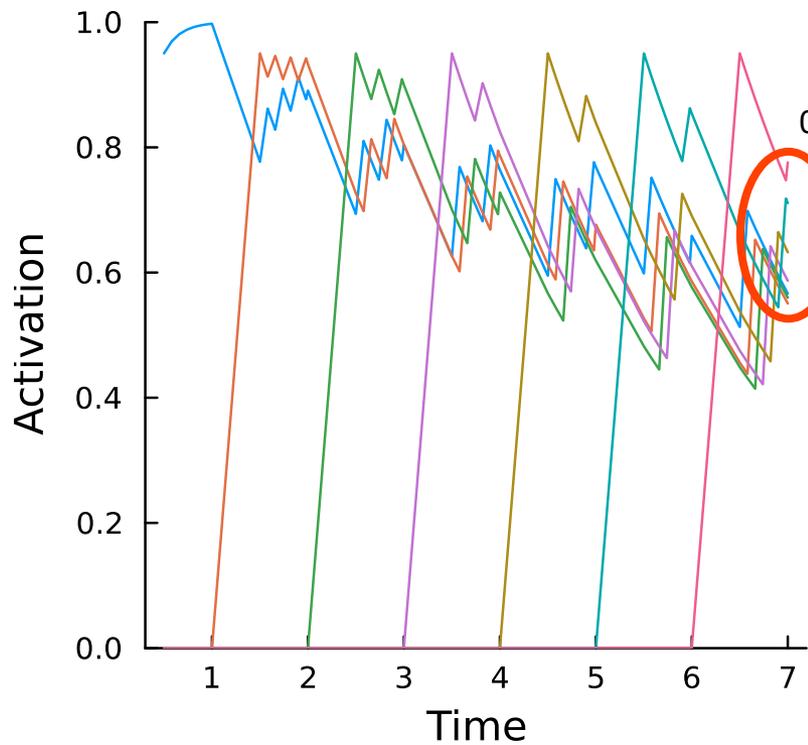
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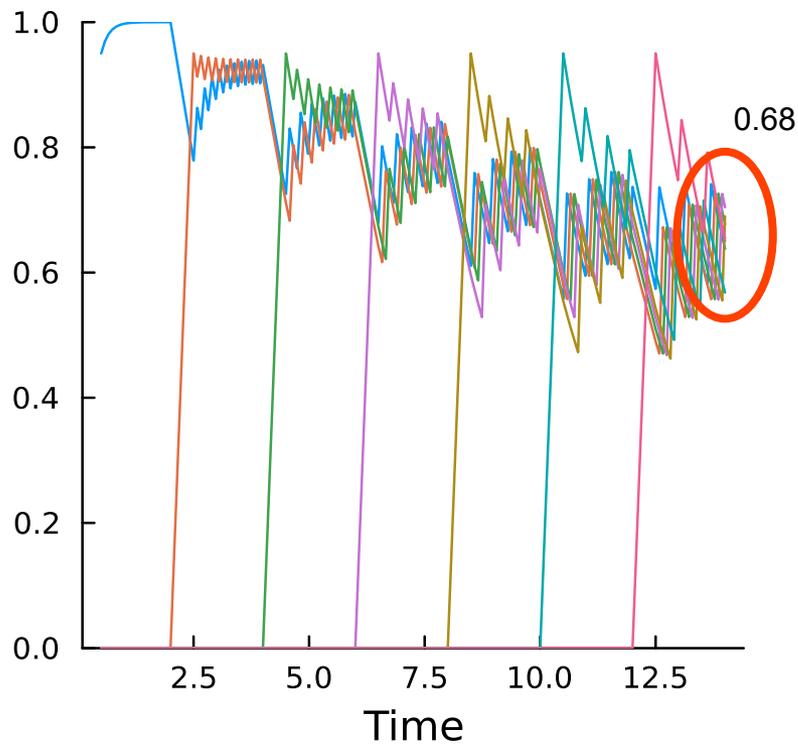
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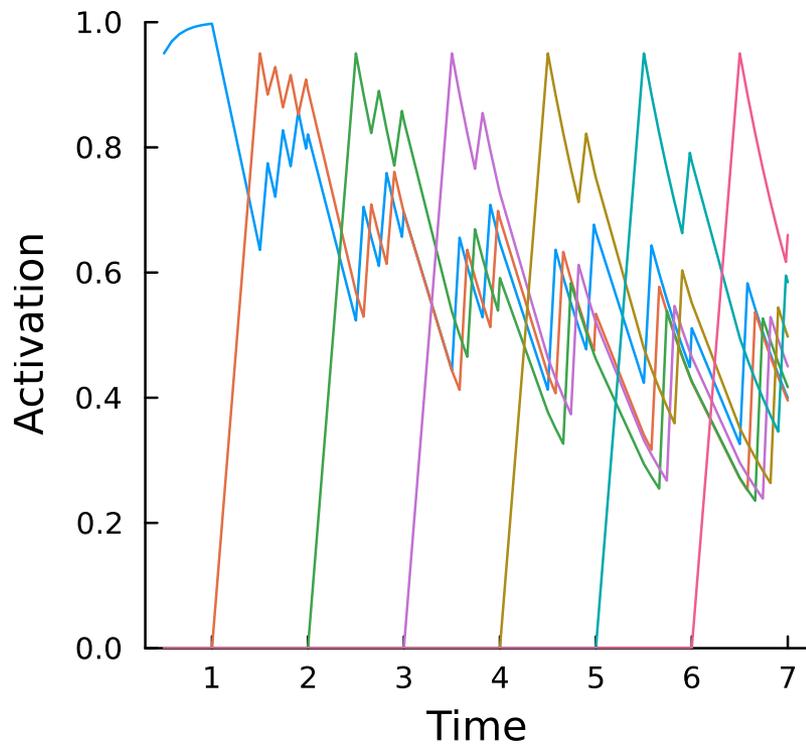
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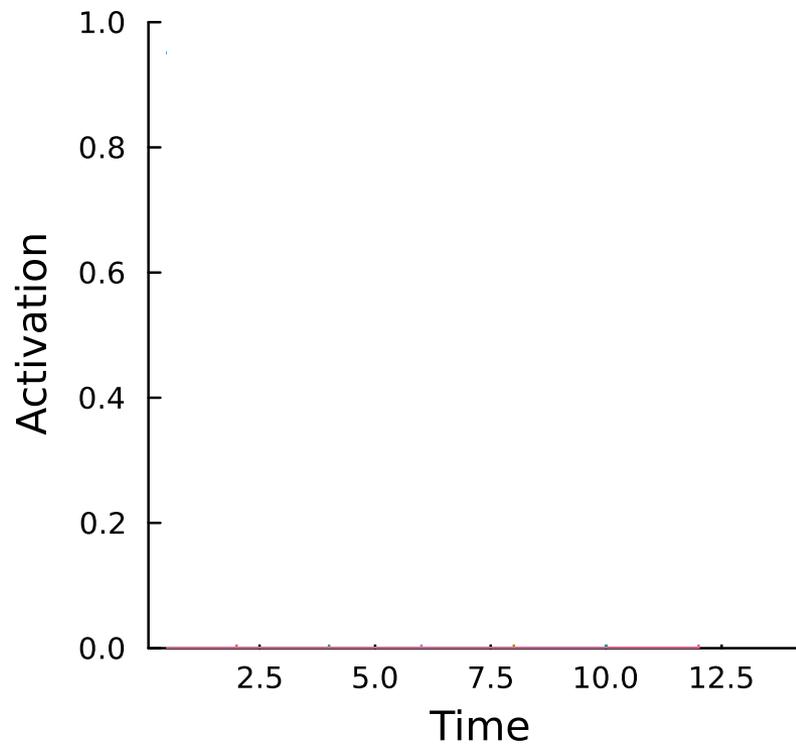
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Stronger decay-based forgetting



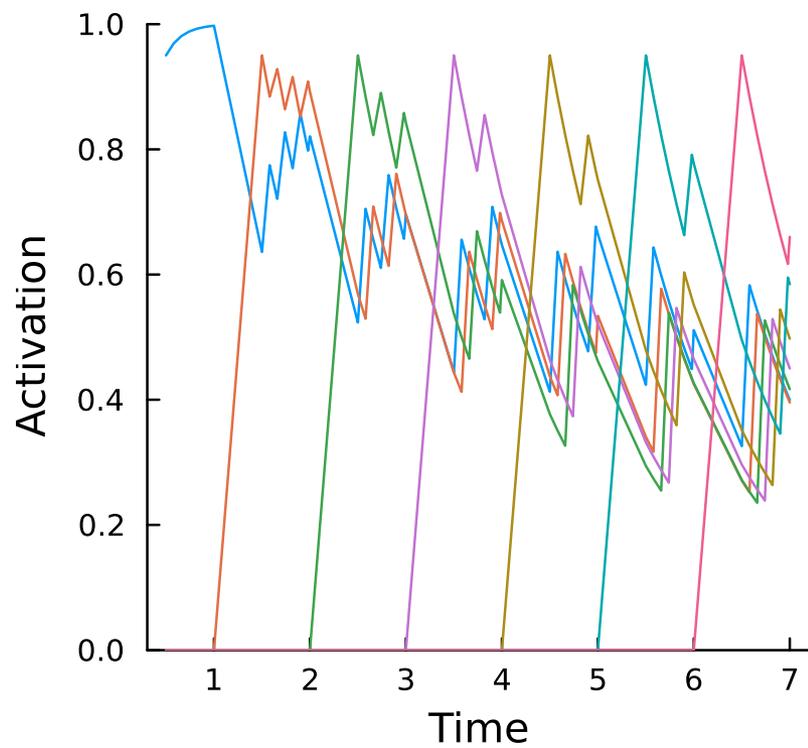
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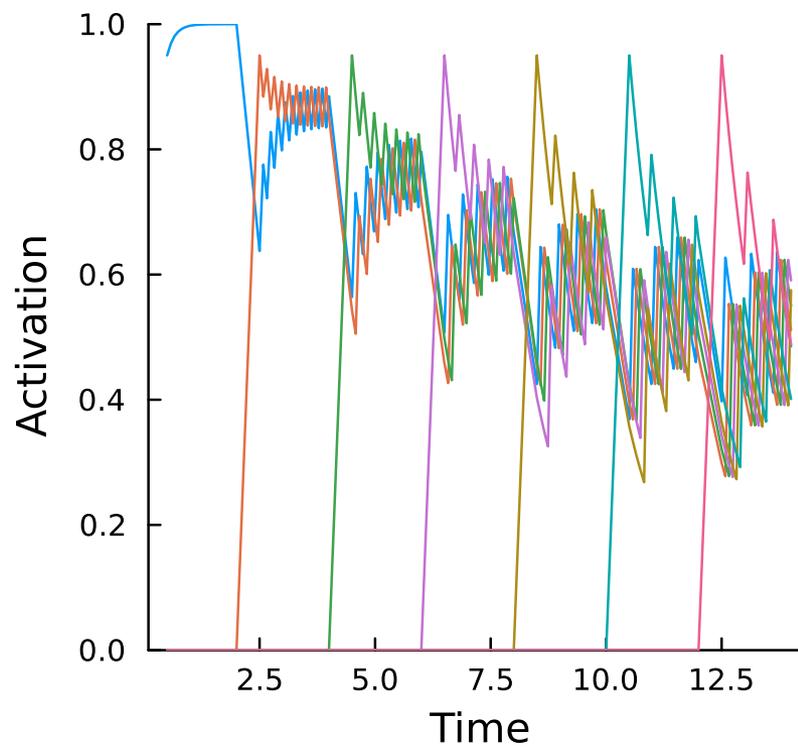
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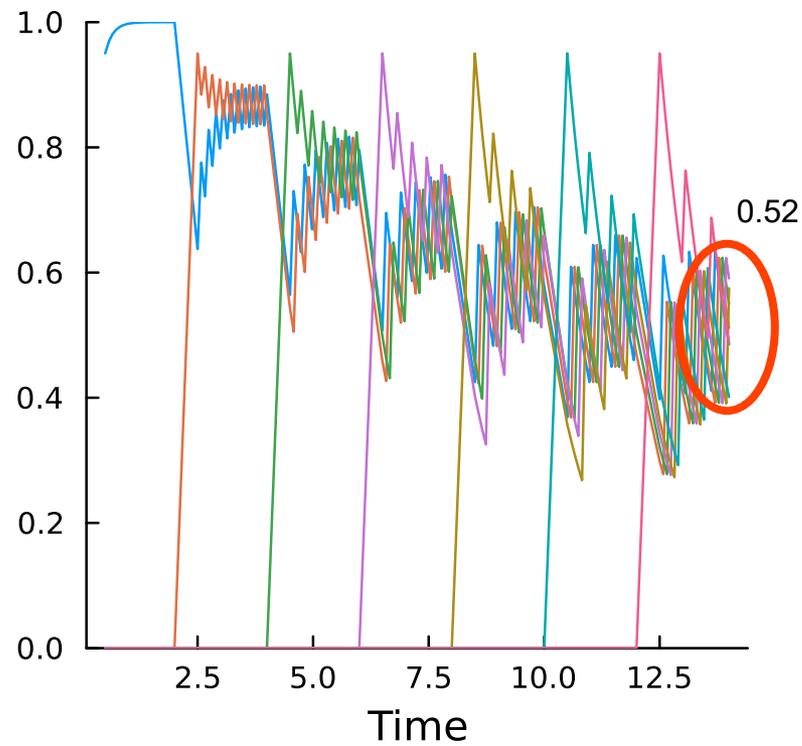
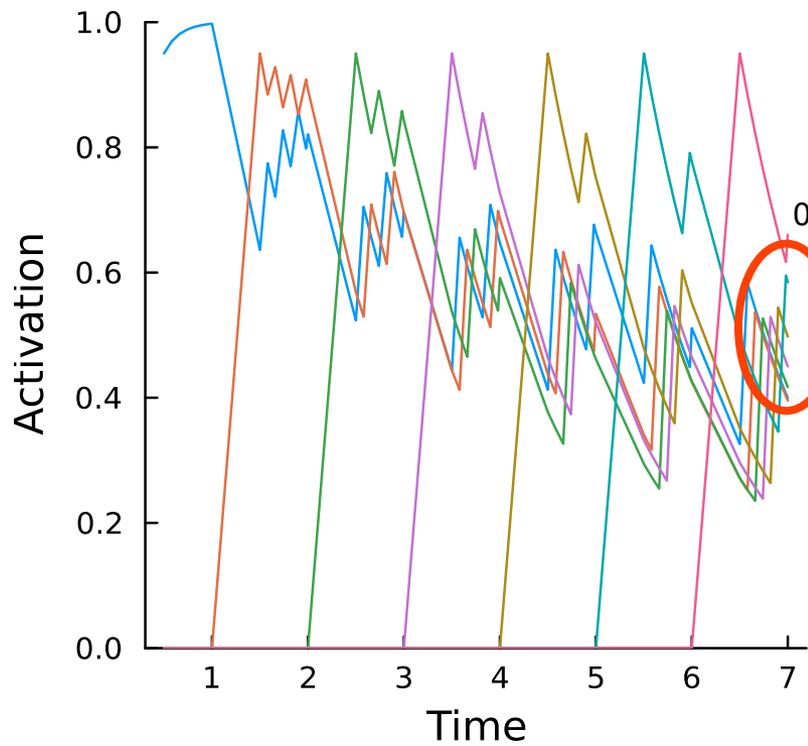
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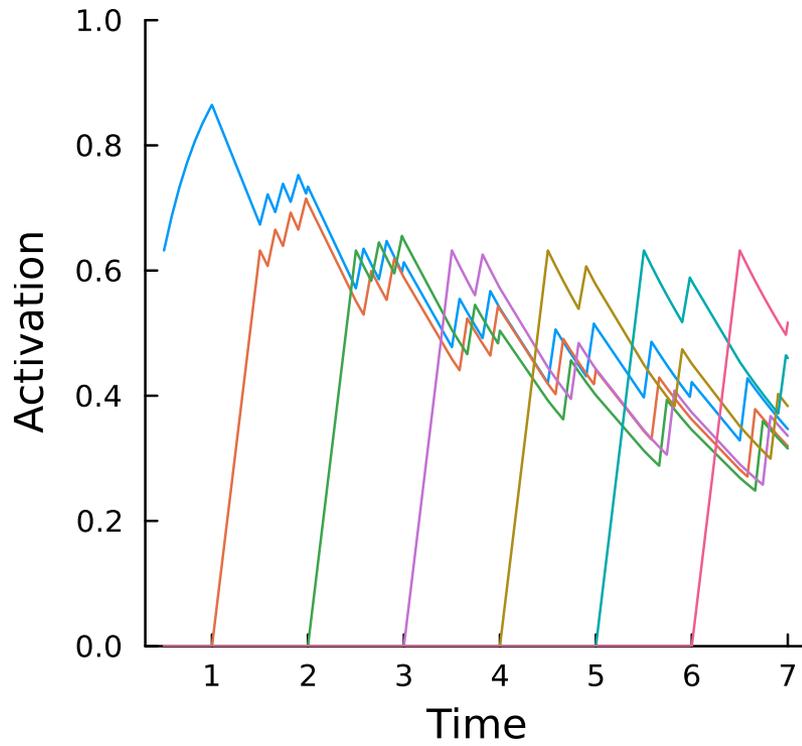
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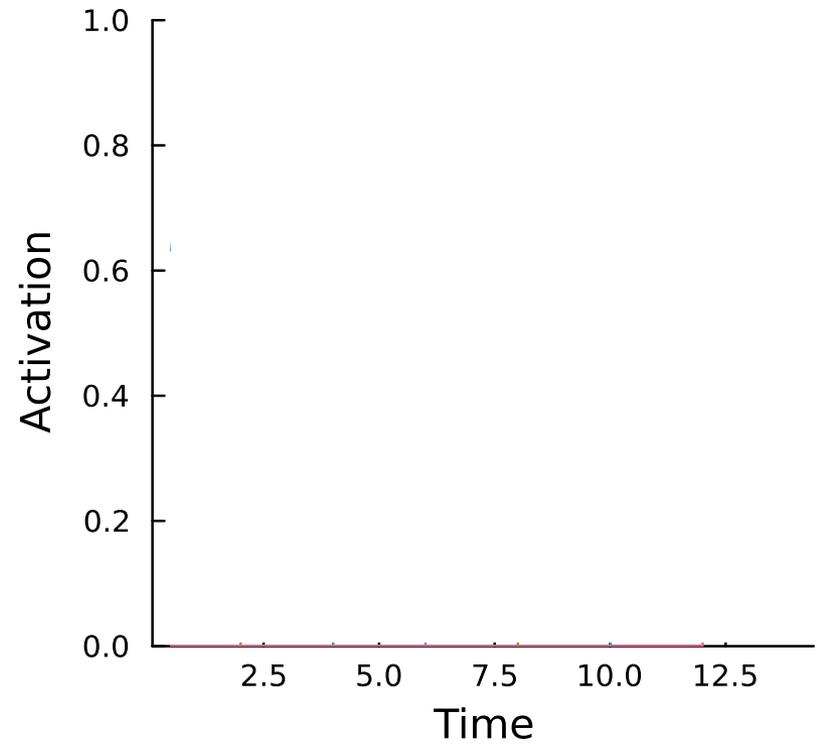
Encoding rate = 6
Decay = 0.9

Weaker encoding/refreshing



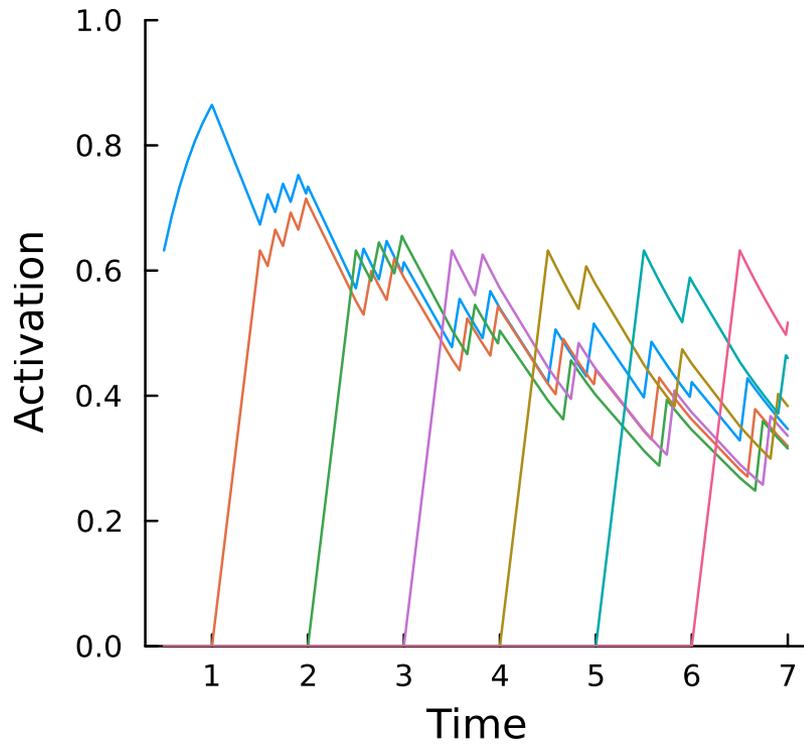
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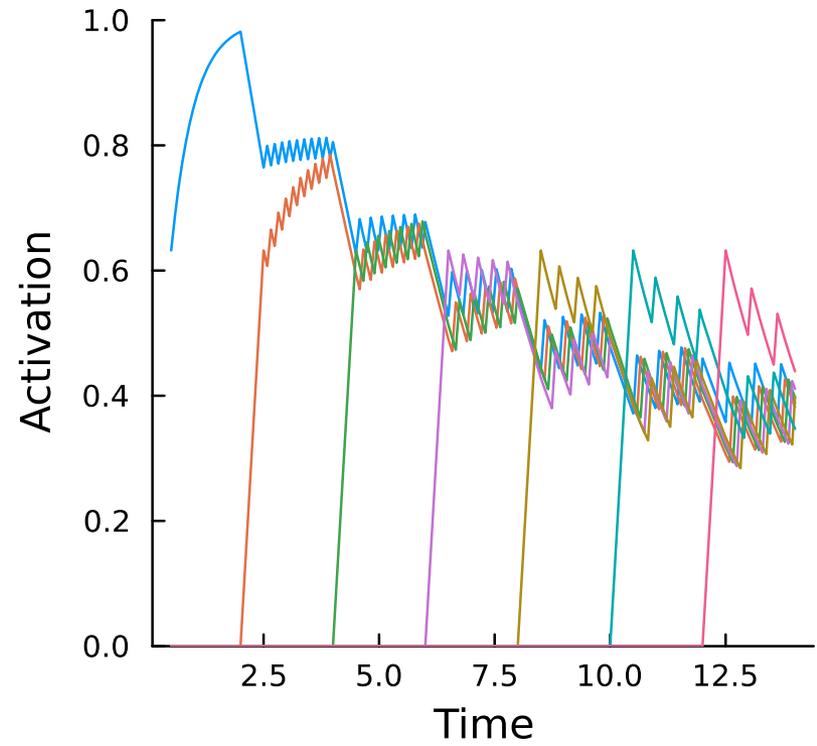
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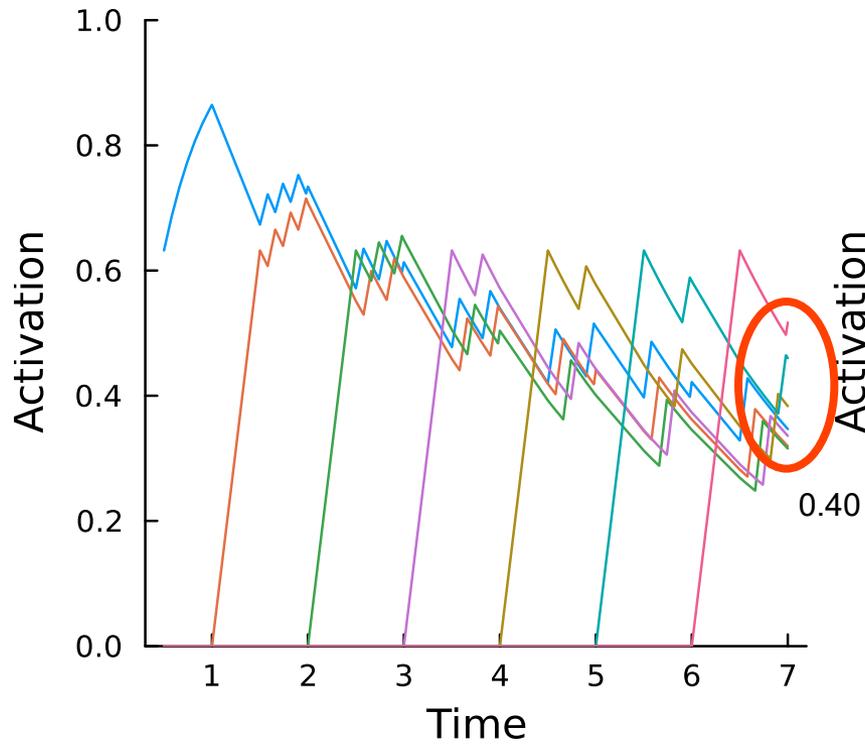
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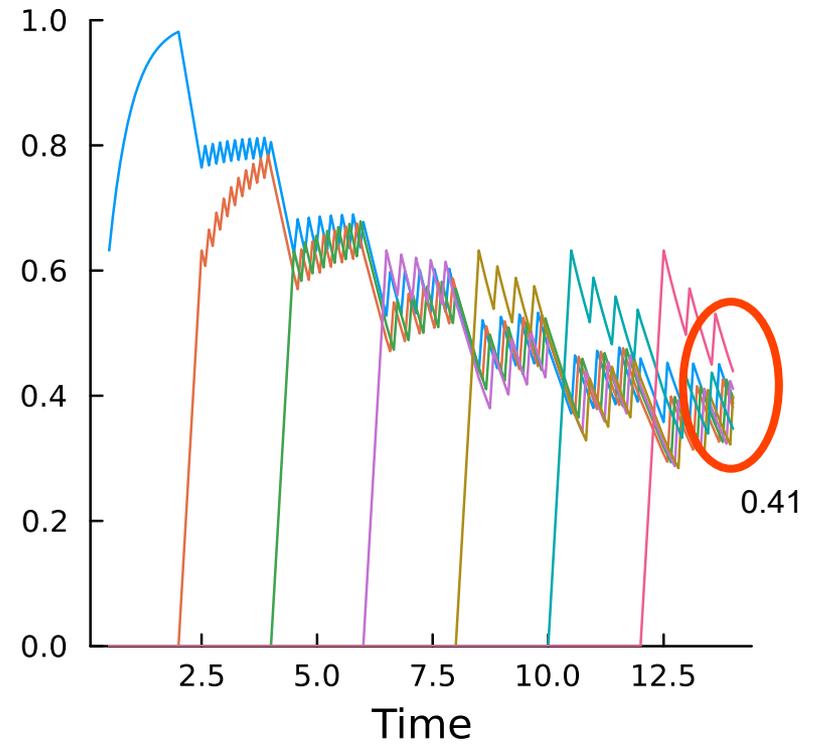


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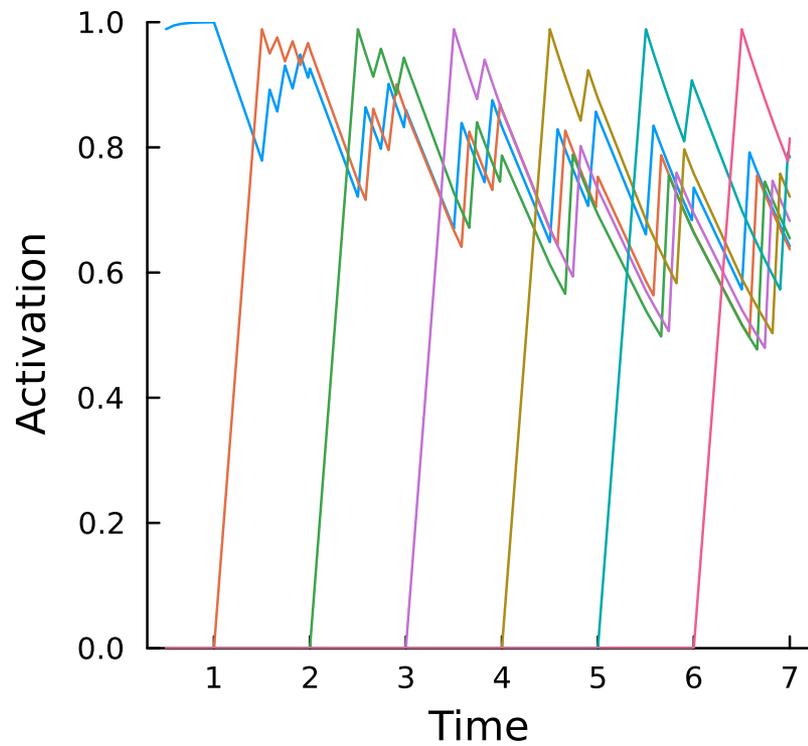
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2s/item

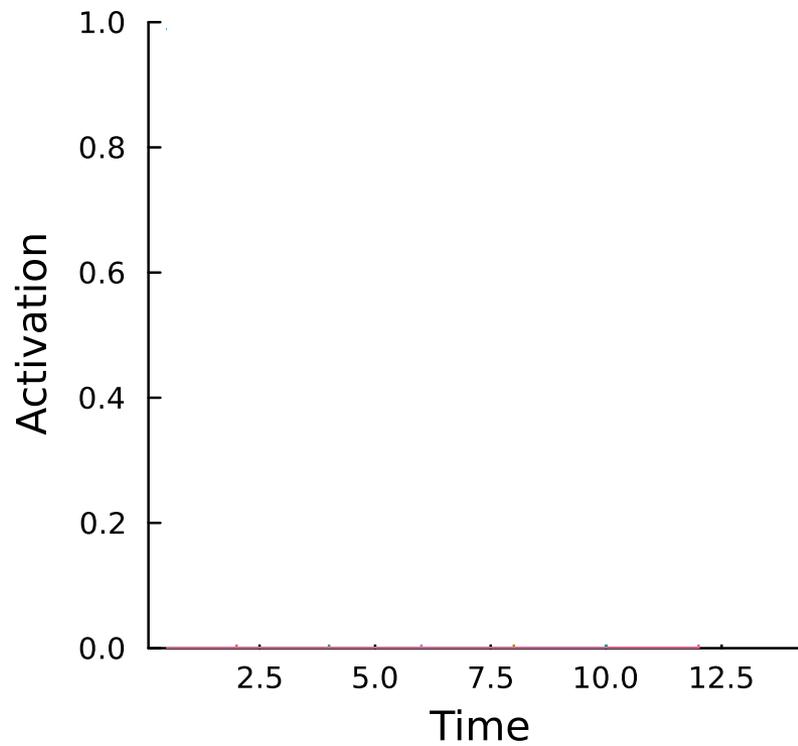
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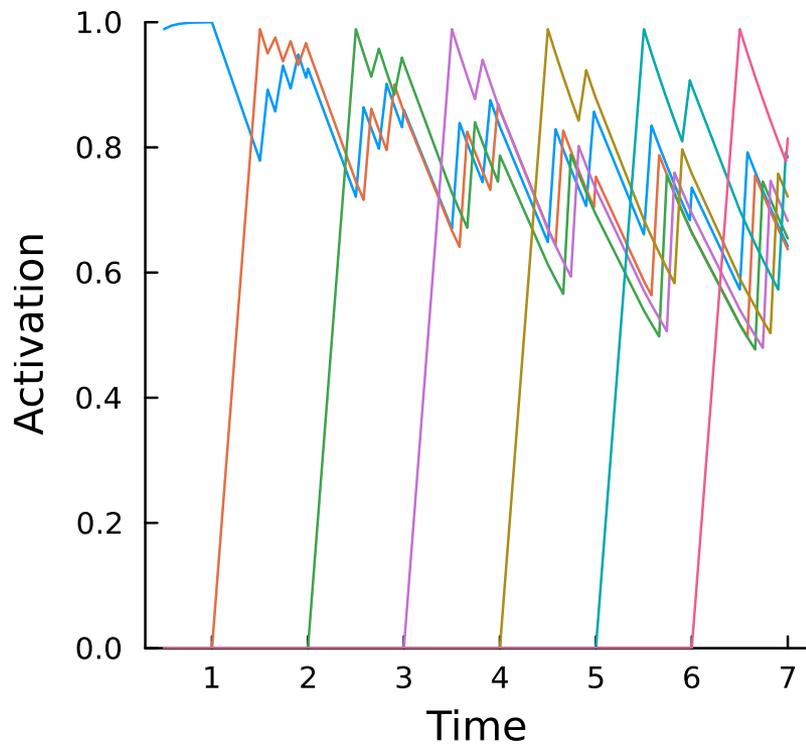
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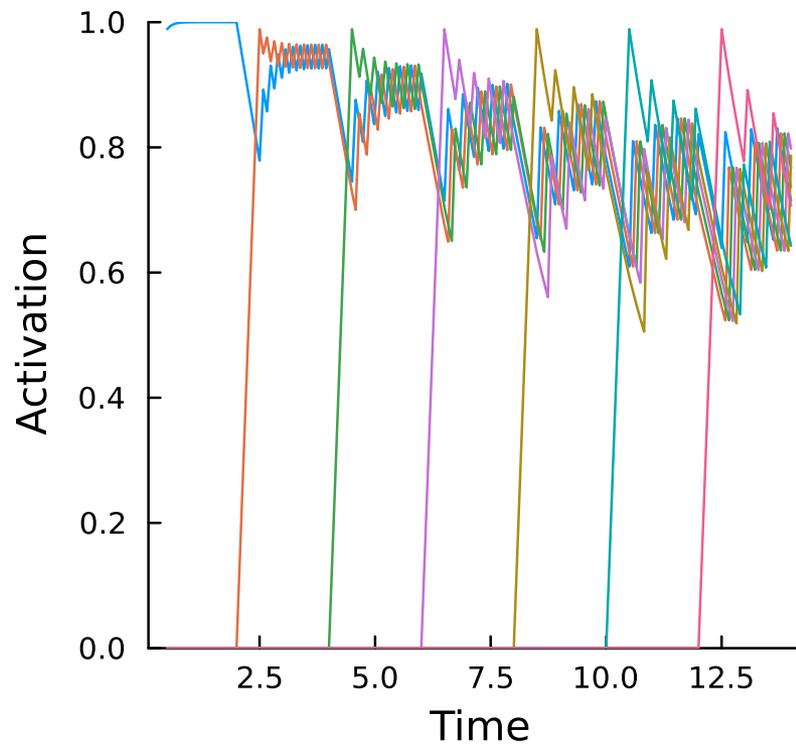
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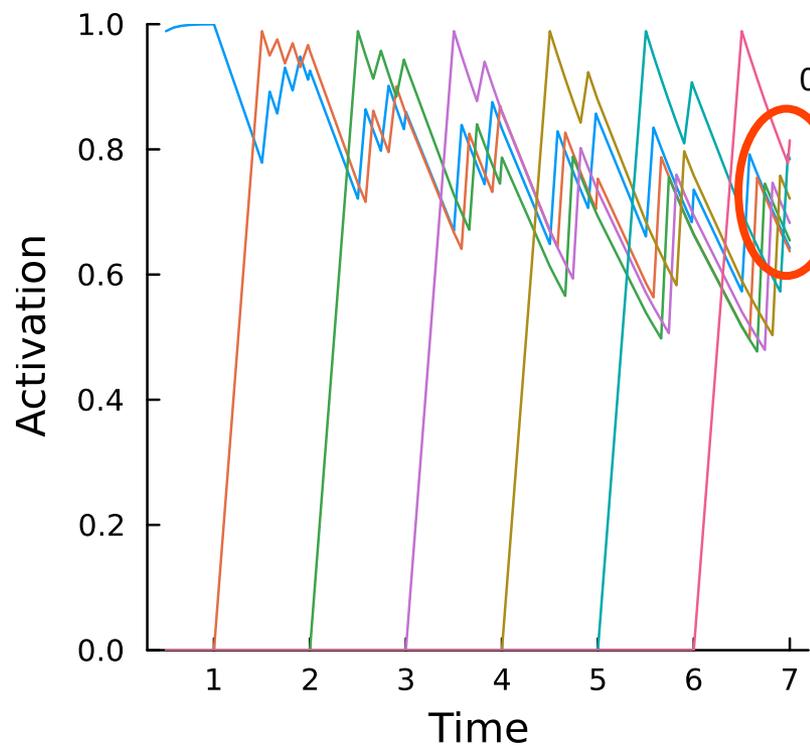
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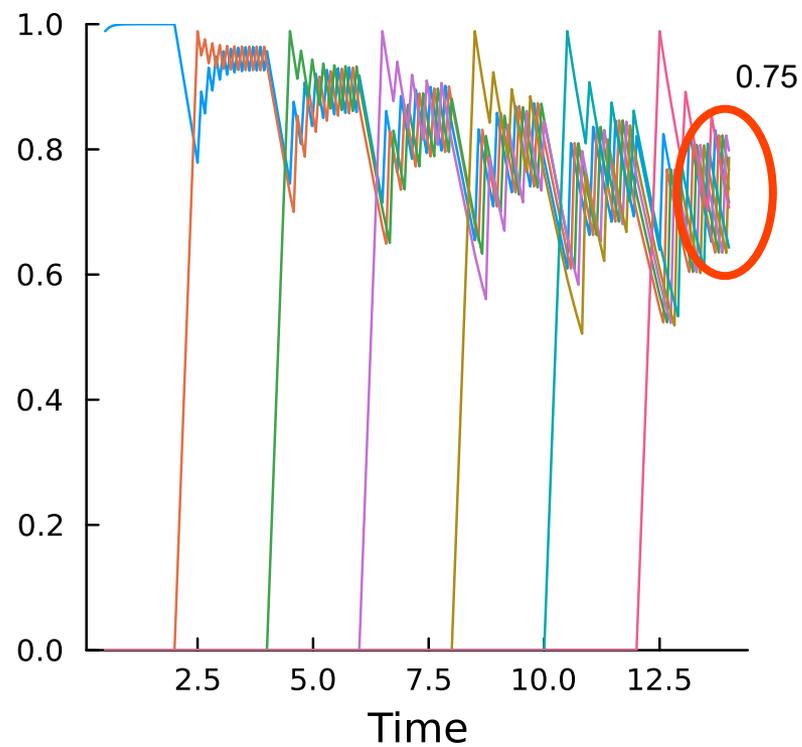


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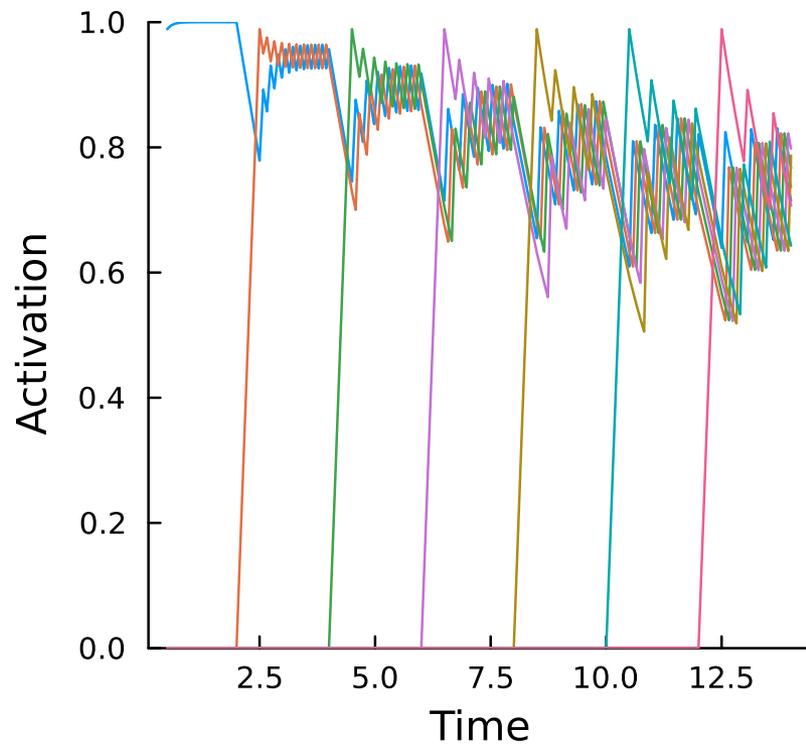
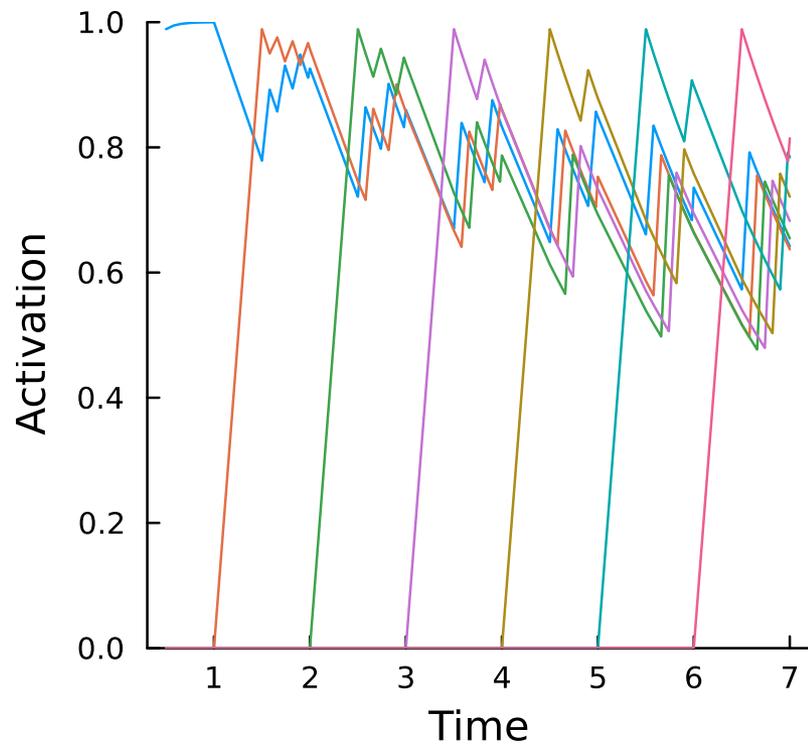


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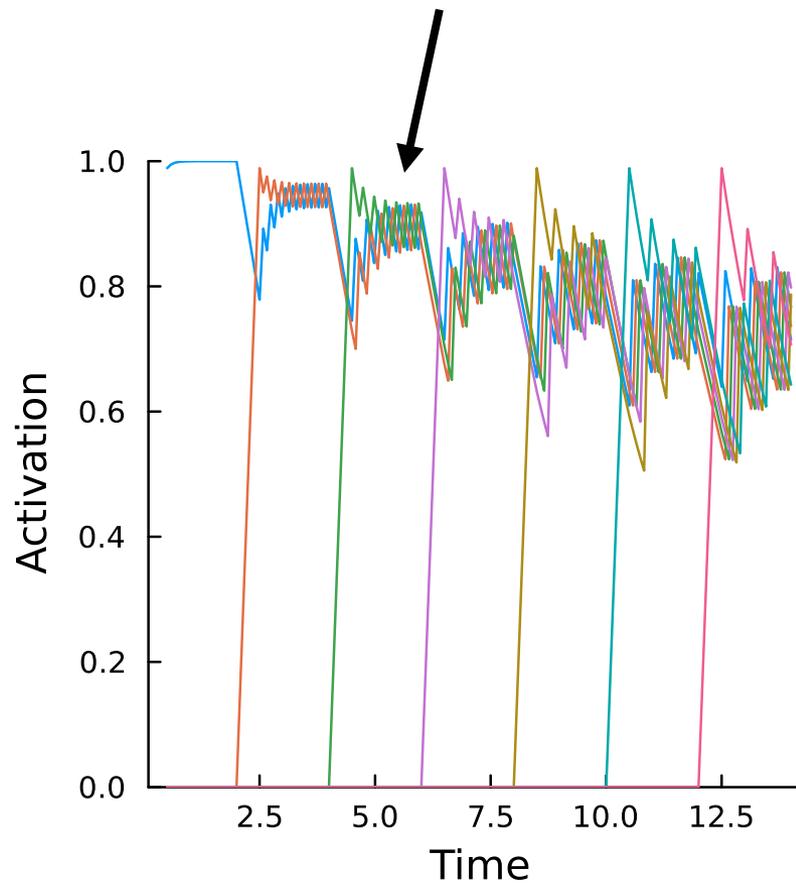
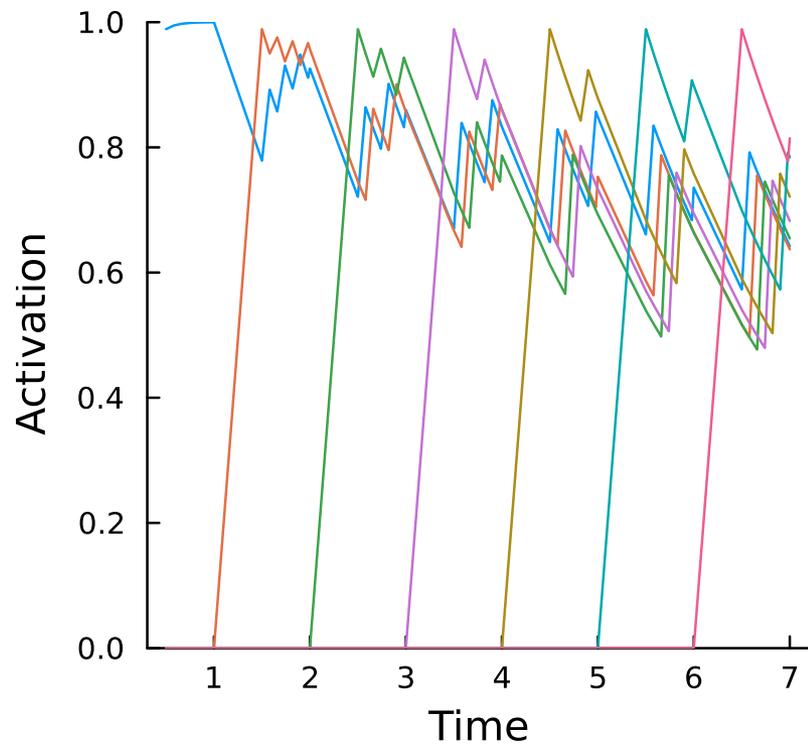


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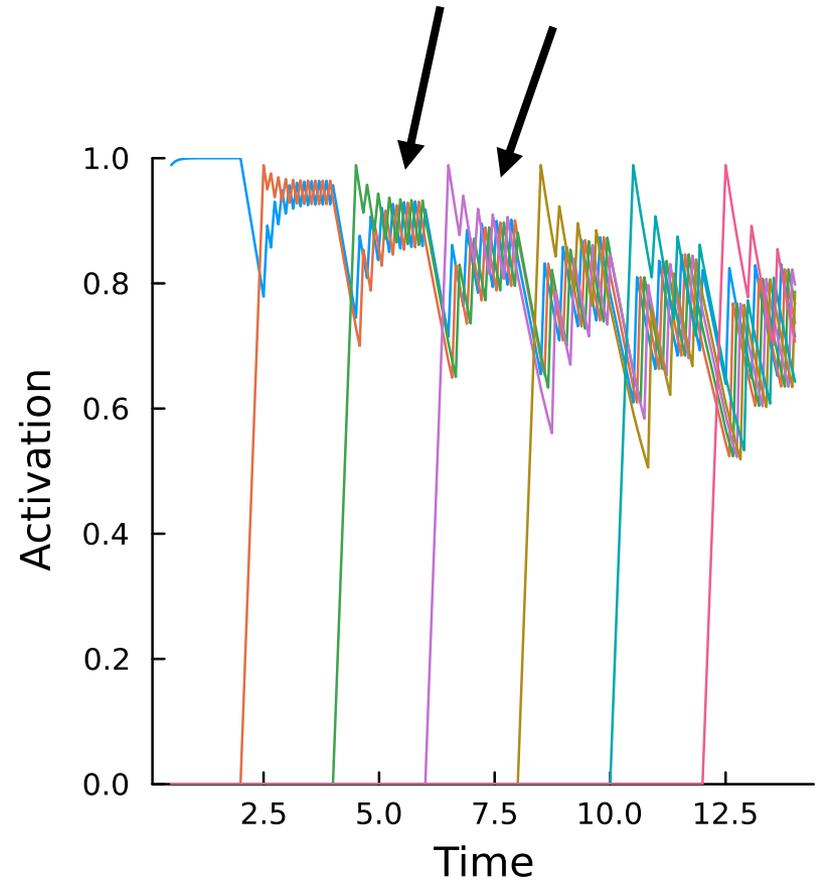
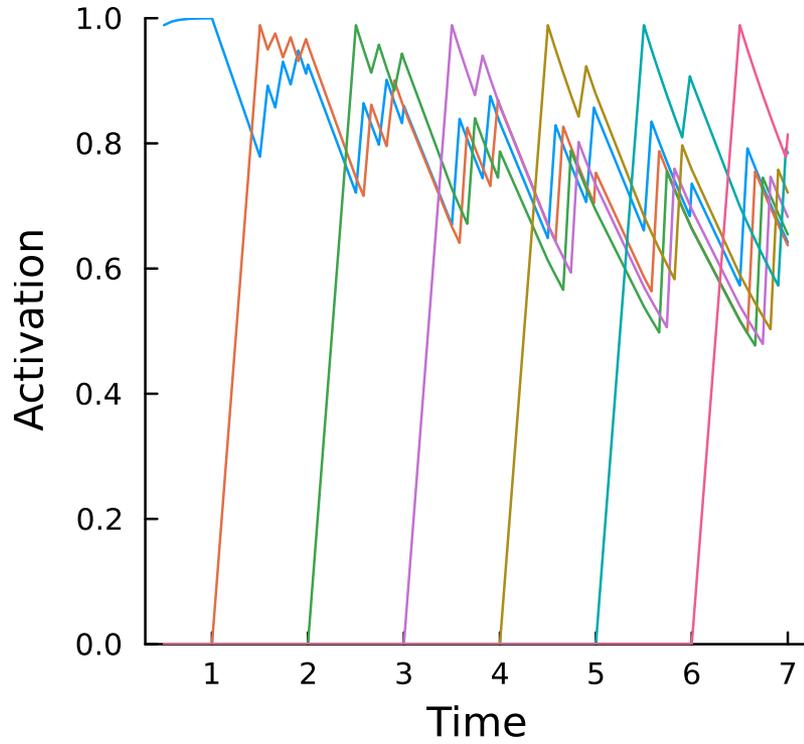
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For a given set size, the model converges towards a constant value

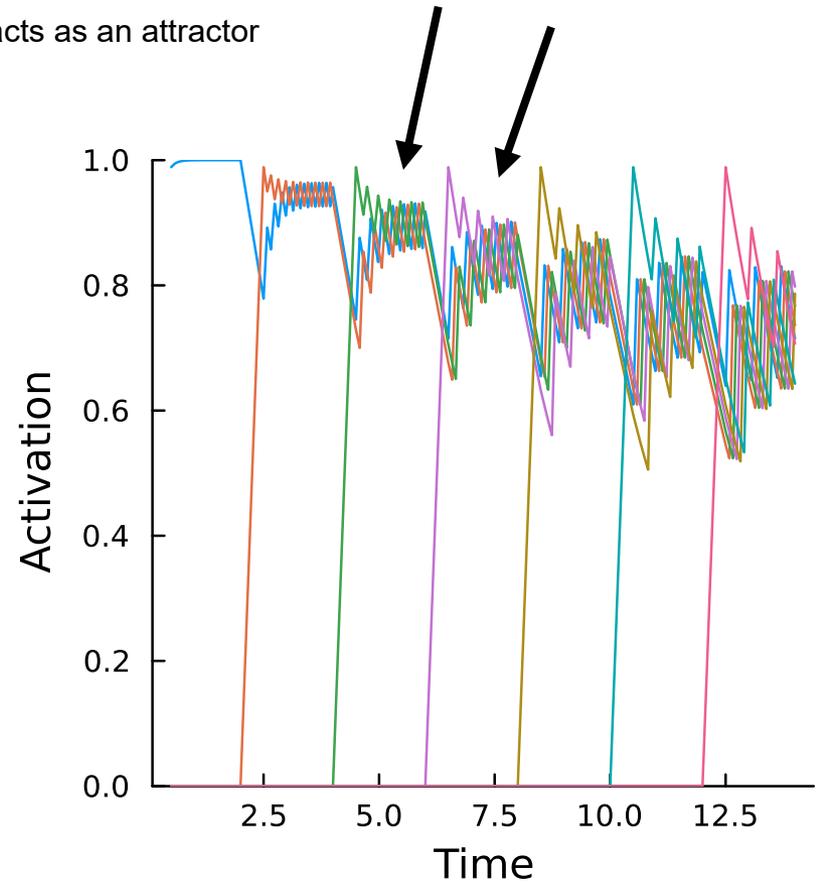
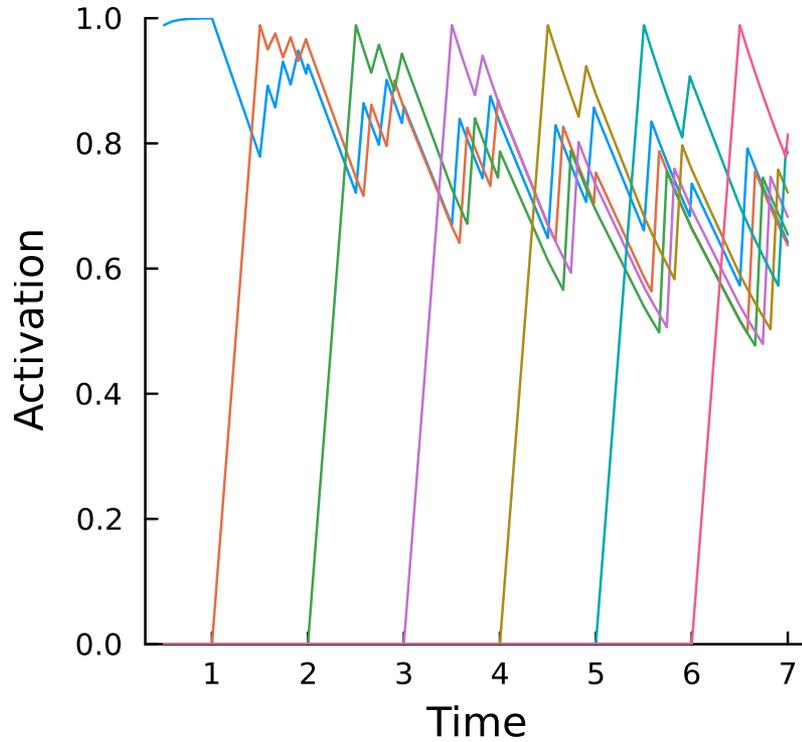


For a given set size, the model converges towards a constant value
Adding more items distributes the refreshing resources, which decreases this value



For a given set size, the model converges towards a constant value
Adding more items distributes the refreshing resources, which decreases this value

Additional time doesn't change this value, which acts as an attractor



In its **simplest form**, this decay and refreshing architecture doesn't produce a free-time benefit.

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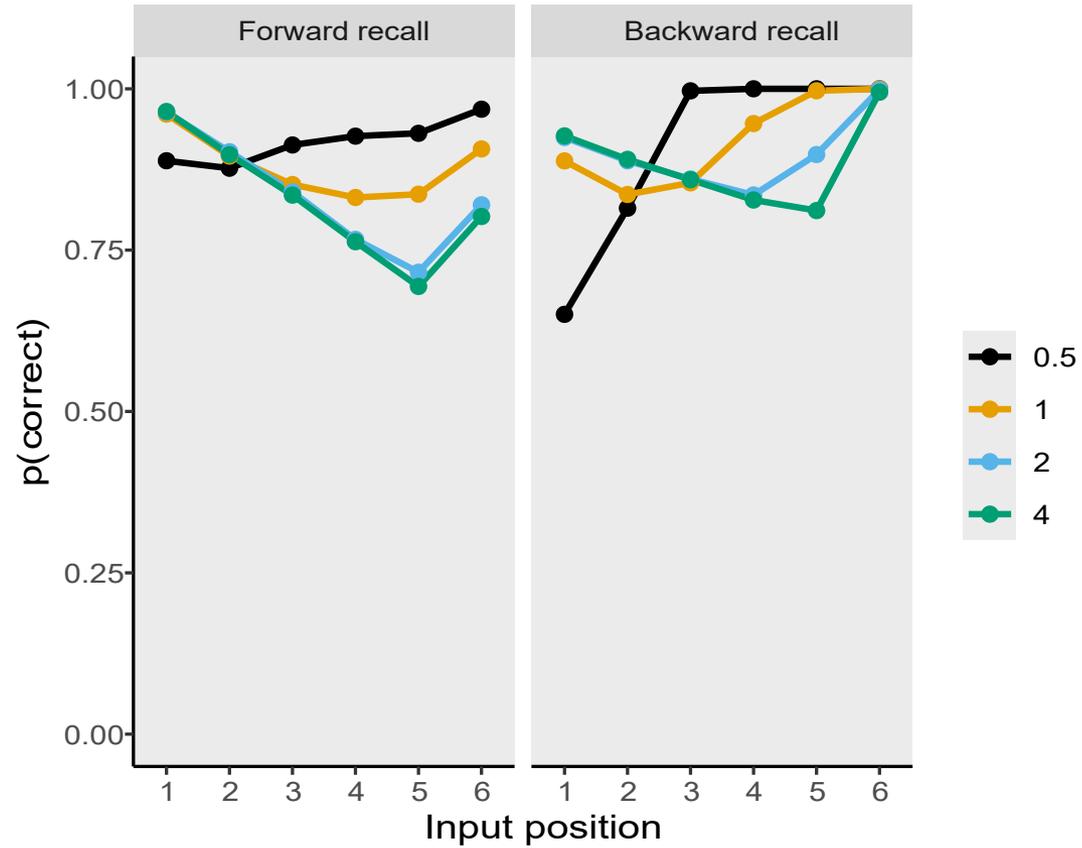
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Retrieval is a noisy and error-prone process.

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In practice, refreshing an item requires retrieving it.
Retrieval is a noisy and error-prone process.

More free-time = more retrieval attempts = more errors

TBRS* (Oberauer & Lewandowsky, 2011, *PB&R*)



Limitation:

By increasing the precision of our theory, we also made it more specific.

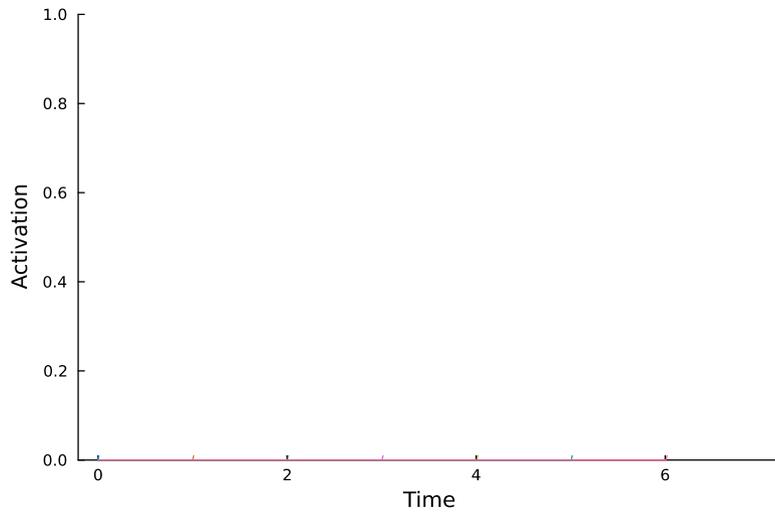
There could be other implementations predicting a free-time benefit.

We could complexify the model:

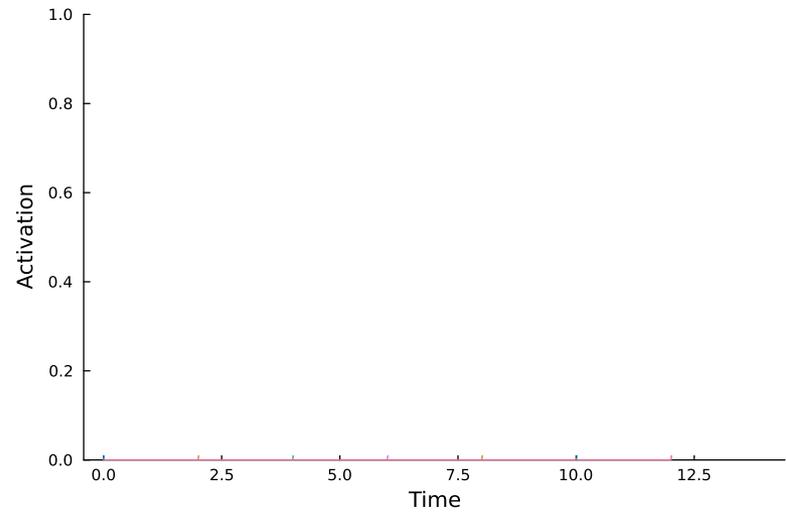
Enrichment mechanism (Ricker & Vergauwe, 2022, *Memory & Cognition*)

Are there alternatives?

Items are not subject to decay-based forgetting
Items are encoded for a period of time as long as the
presentation time itself.

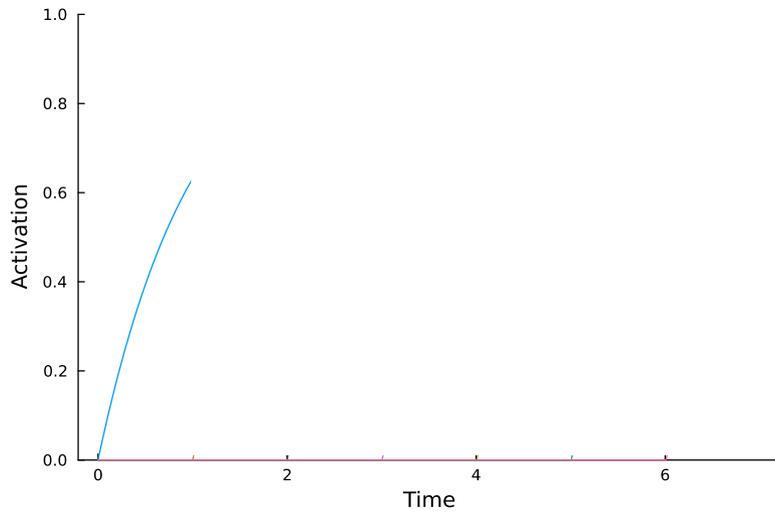


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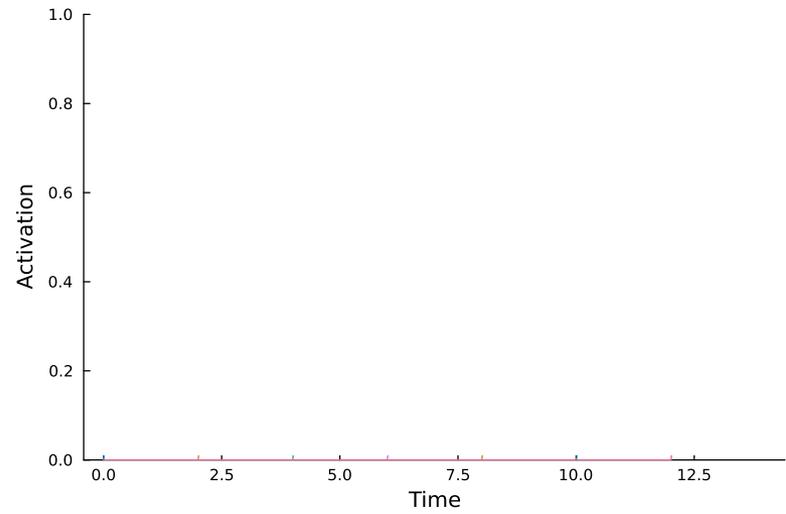


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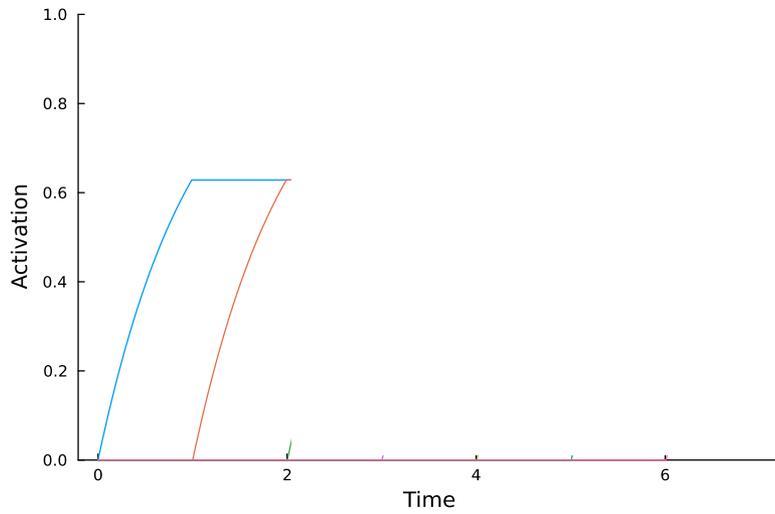


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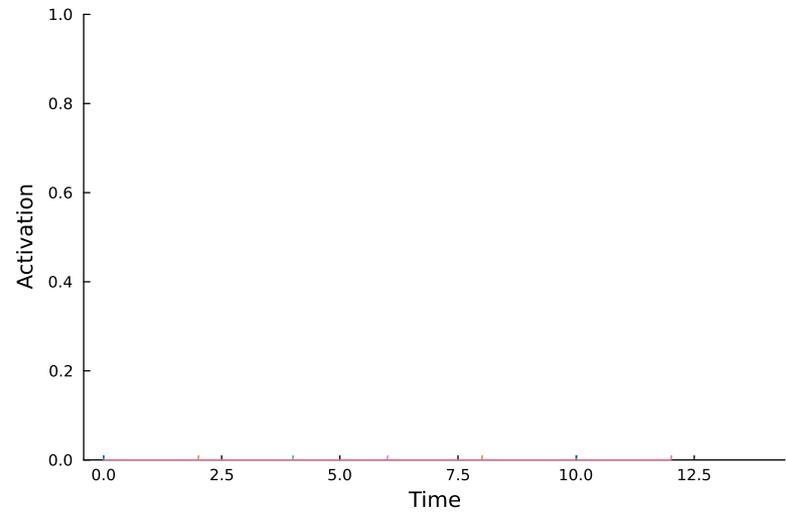


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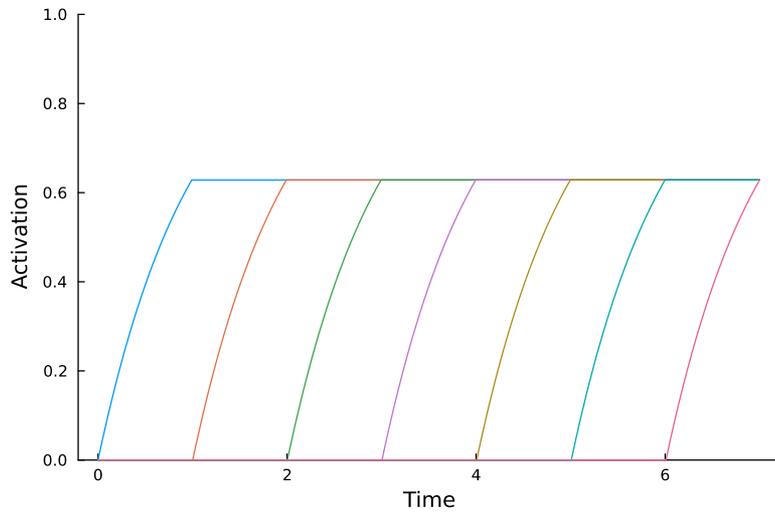


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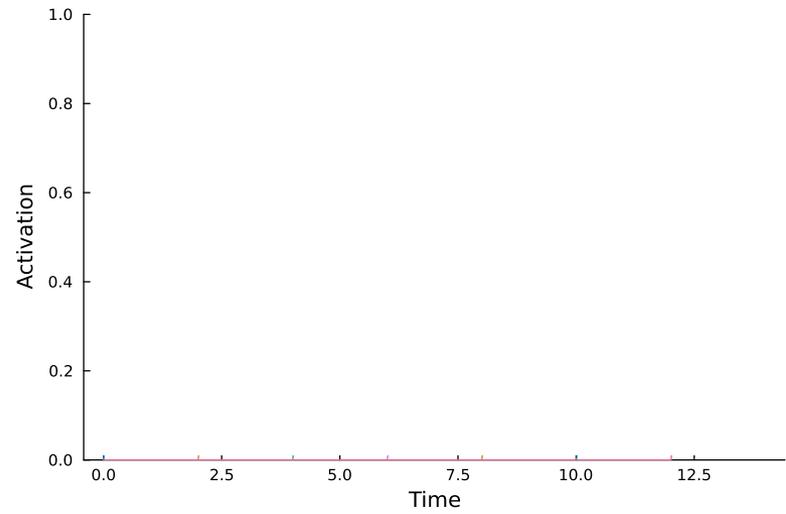


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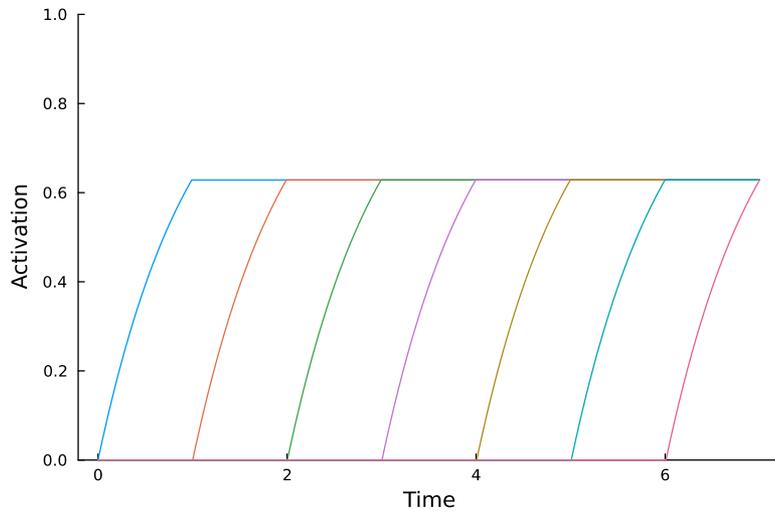


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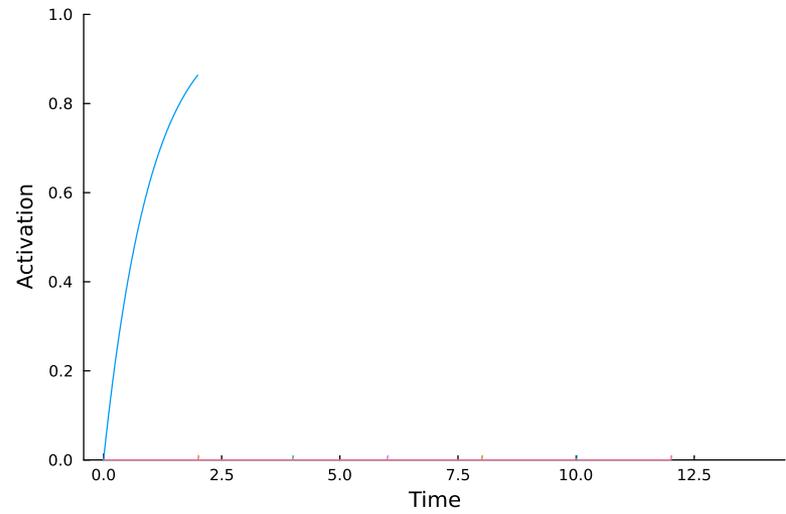


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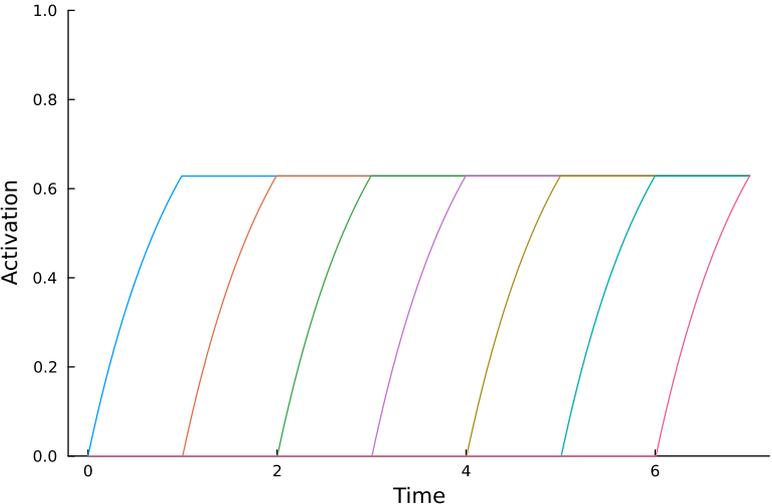


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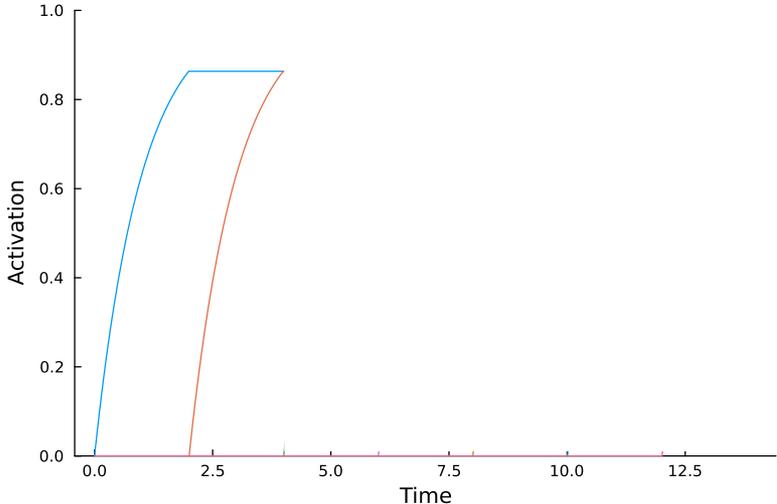


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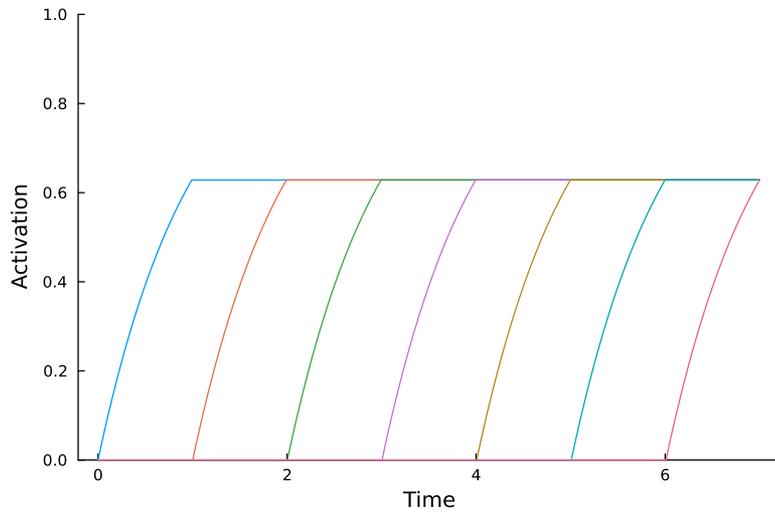


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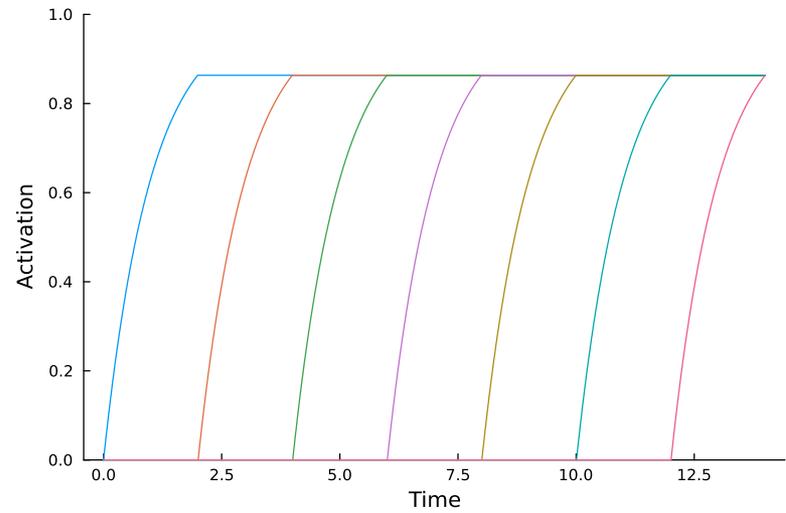


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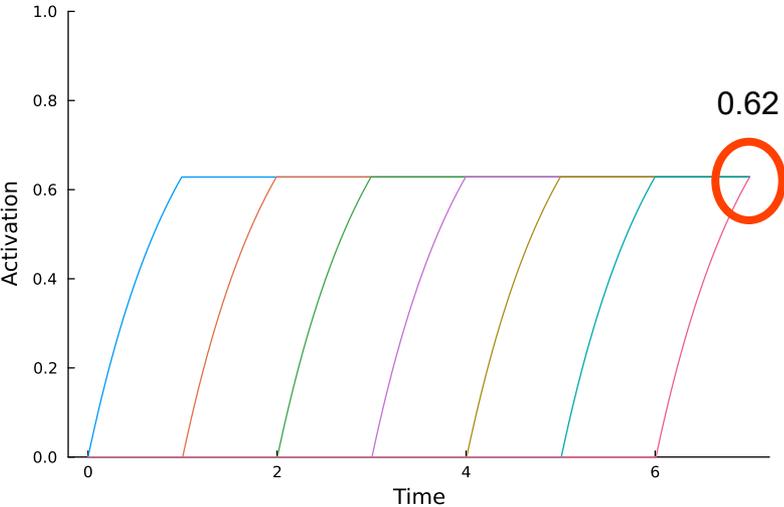


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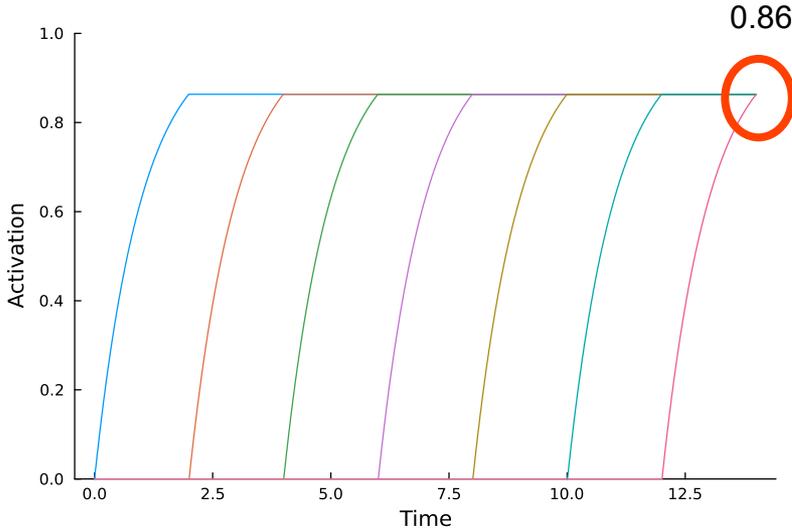


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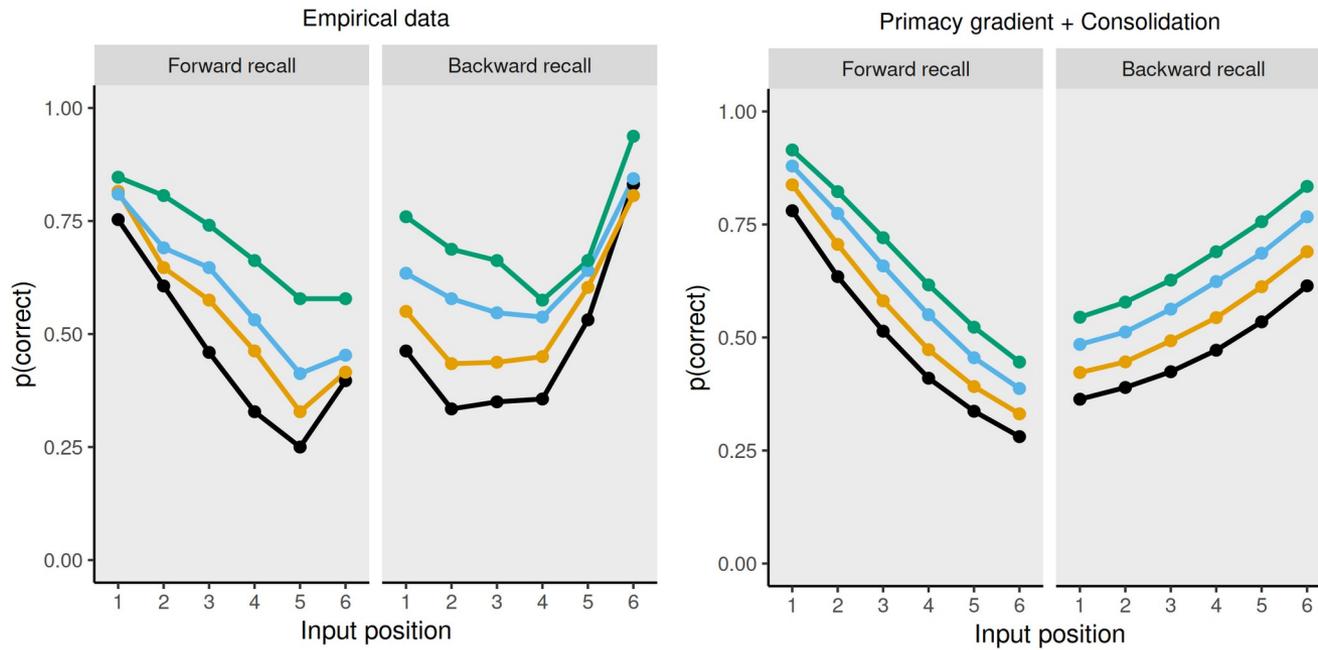
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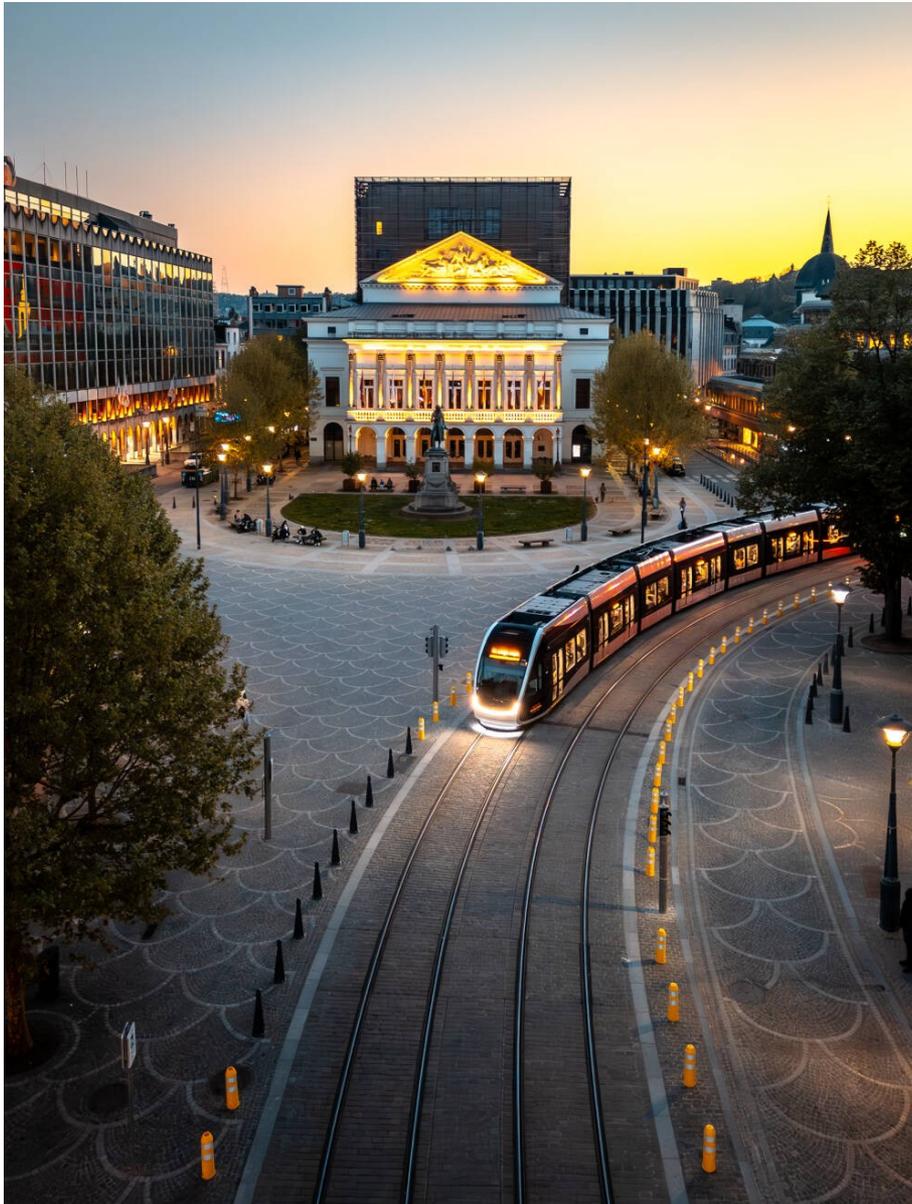
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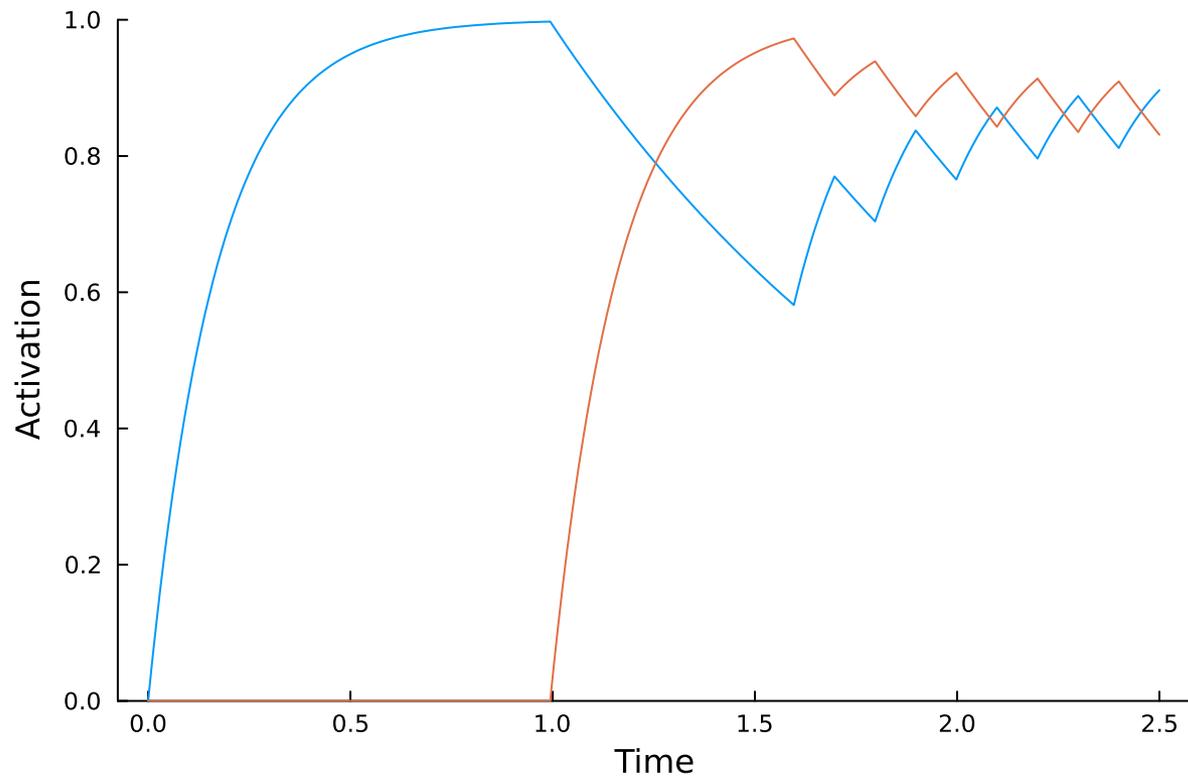
We improved the predictions by **removing** one assumption



Mèrci bràmint dèss còps

Photo: Arnaud Sauvage

$R = 6$
 $D = 0.9$



$R = 2$
 $D = 0.5$

