Attention!

...and it's use in Deep Learning

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Stockholm AI - Reading Group
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What about it?

Self driving cars

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What about it?

Machine Translation

“narrow down the focus to the most relevant parts”

“recentrez l'attention sur les éléments les plus pertinents”

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What about it?

Solving Problems (Logical Reasoning)

“many times complexity
is a collection of
connected simplicities”

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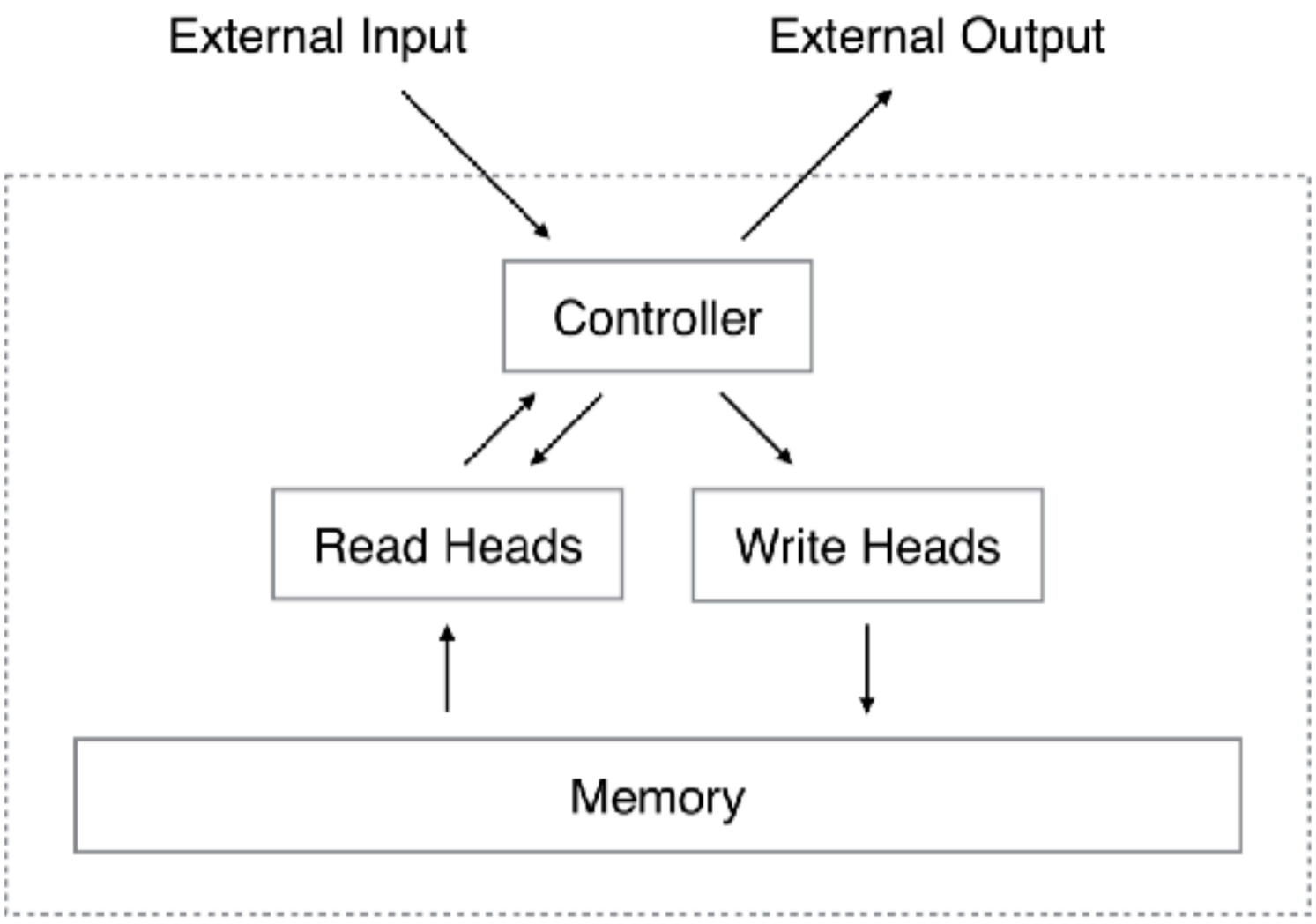
What about it?

Solving Problems (Logical Reasoning)



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Agenda

- Problem Formulation
- Spatial Attention
  - Example/Benchmark
  - Applications
- Beyond Spatial Attention
  - Differentiable Neural Computers
- Discussion and Questions

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Iterative Application of Attention (RNN)

Regular RNN/LSTM/GRU…

$$y^t, s^t = f(x^t, s^{t-1}) \qquad y^{1:T}, s^{1:T} = RNN_f(x^{1:T}, s^0)$$

With Attention ($\mathbf{Z}$)

$$y^t, s^t = g(x^t, s^{t-1}, \mathbf{Z}) \qquad y^{1:T}, s^{1:T} = RNN_g(x^{1:T}, s^0, \mathbf{Z})$$

E.g. by *altering input* to the regular RNN/GRU/LSTM…

$$y^t, s^t = f(x'^t, s^{t-1}), \quad x'^t = a(x^t, s^{t-1}, \mathbf{Z})$$

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Attention Mechanisms

At each time step *t* we predict a **weighting** over input **Z** and map it to an attention encoding z^t

$$y^t, s^t = f(x'^t, s^{t-1})$$

$$x'^t = a(x^t, s^{t-1}, \mathbf{Z}) = [x^t, z^t(x^t, s^{t-1}, \mathbf{Z})]$$

There are many options for how to do this…

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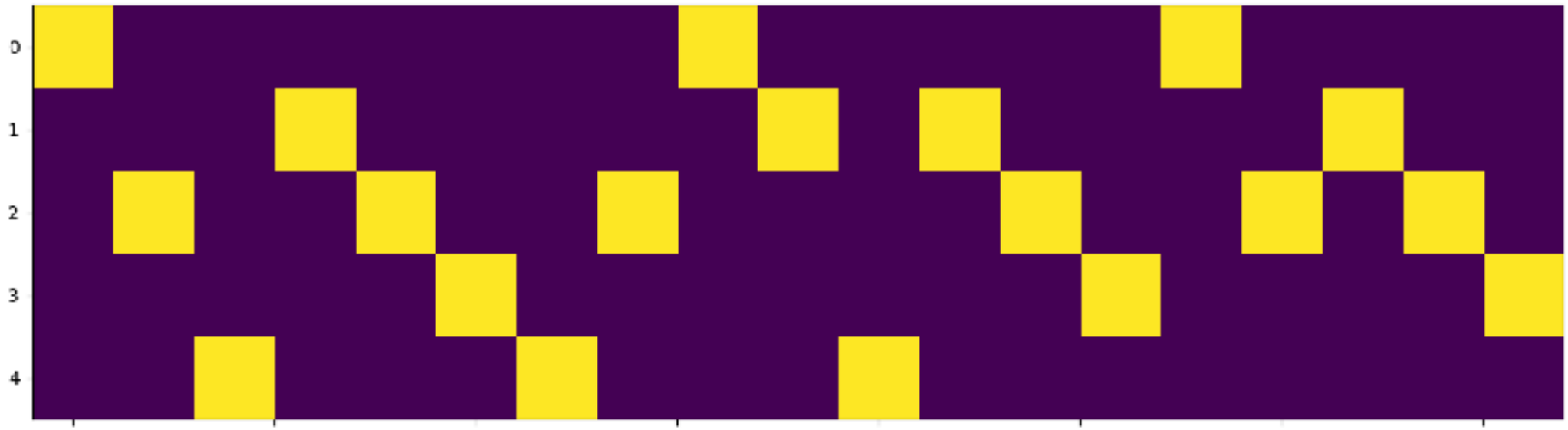
Spatial Attention: 1D



At each time step *t* we predict a **weighting** over input sequence **Z** and map it to an attention encoding z^t

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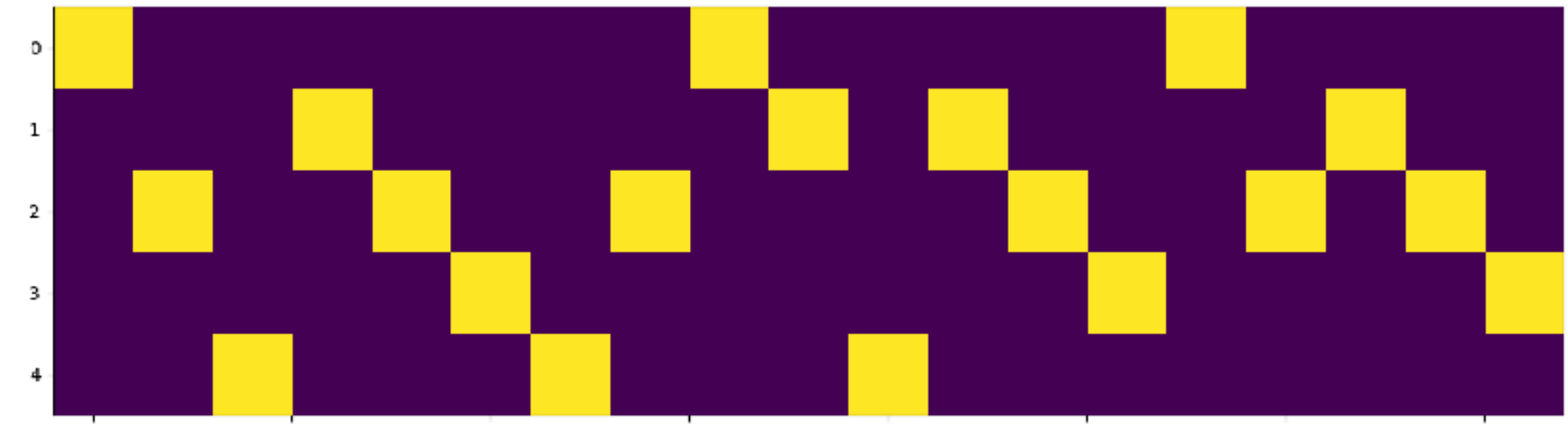
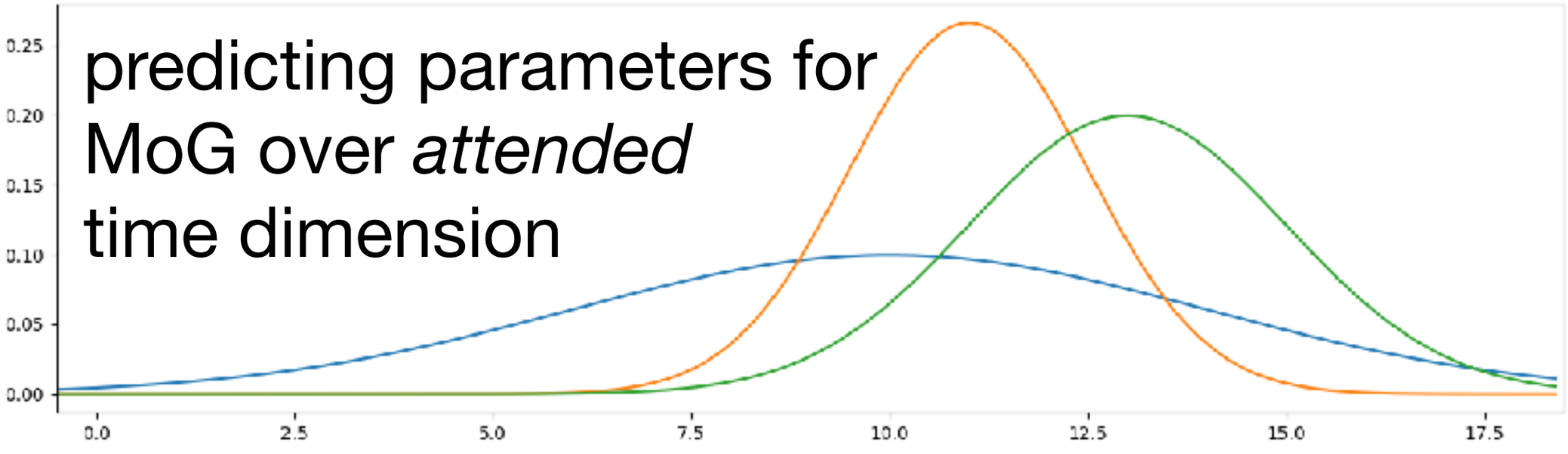
Spatial Attention: 1D





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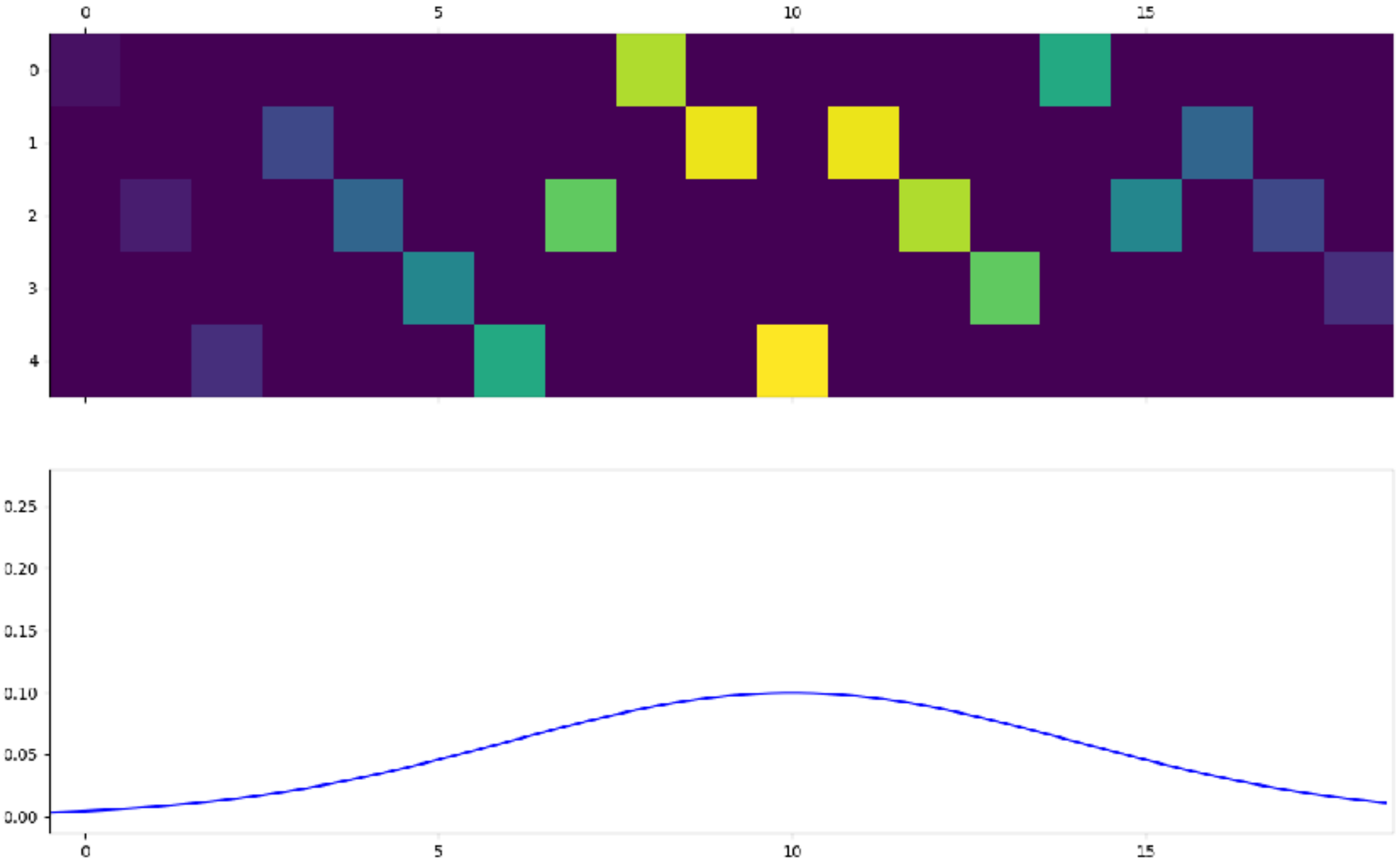
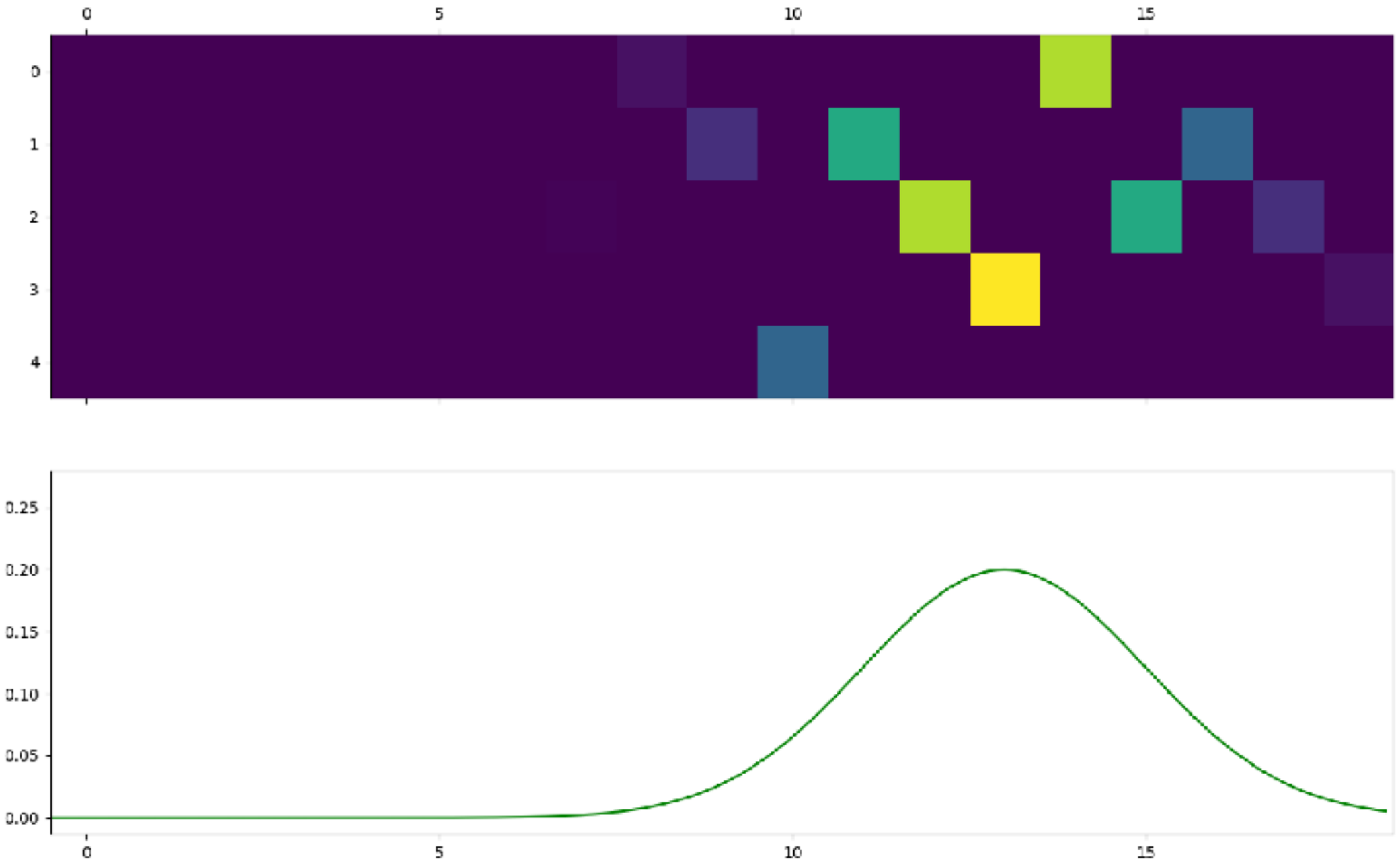
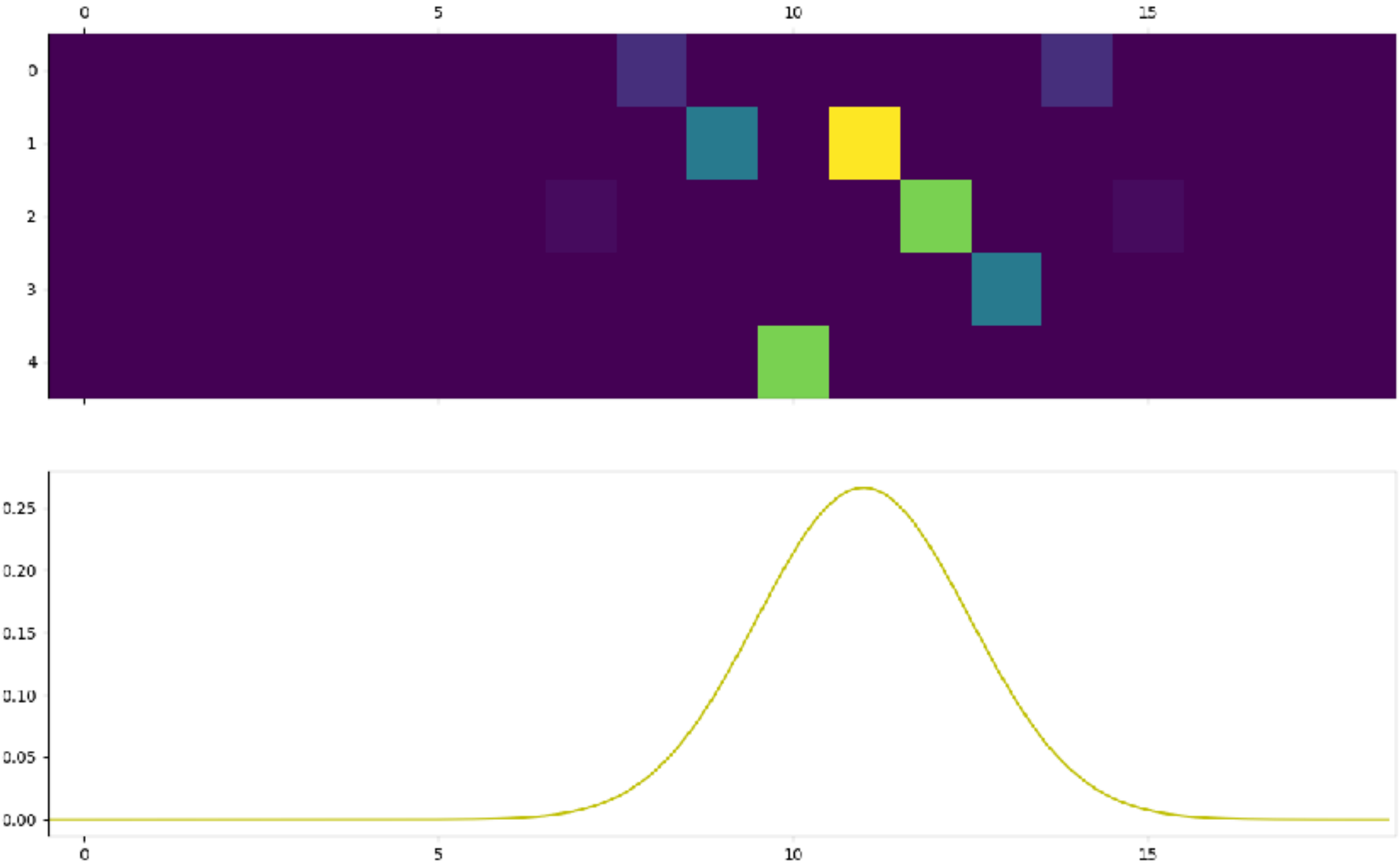


Spatial Attention: 1D



Spatial Attention: 1D



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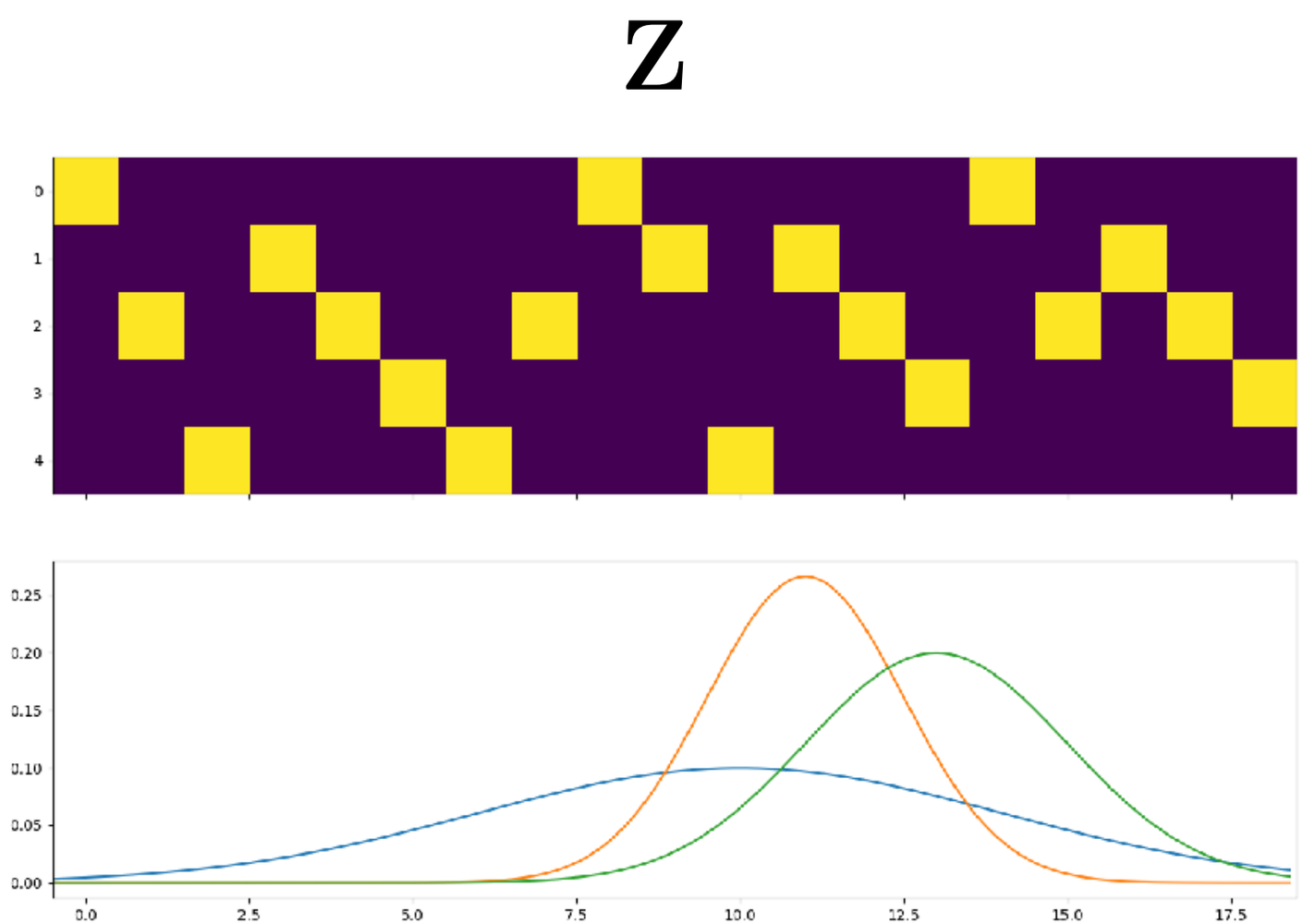

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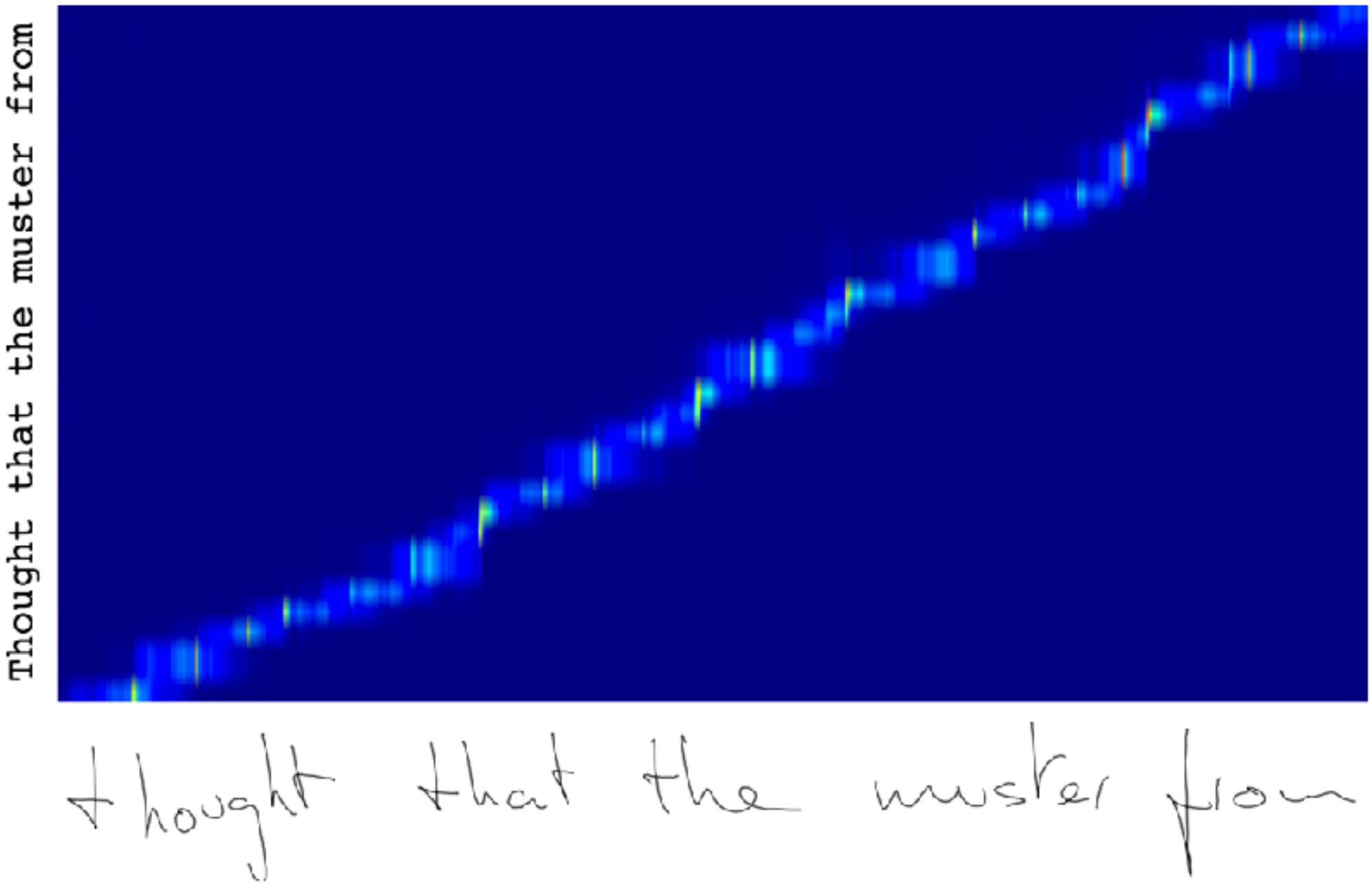
Application: Handwriting synthesis



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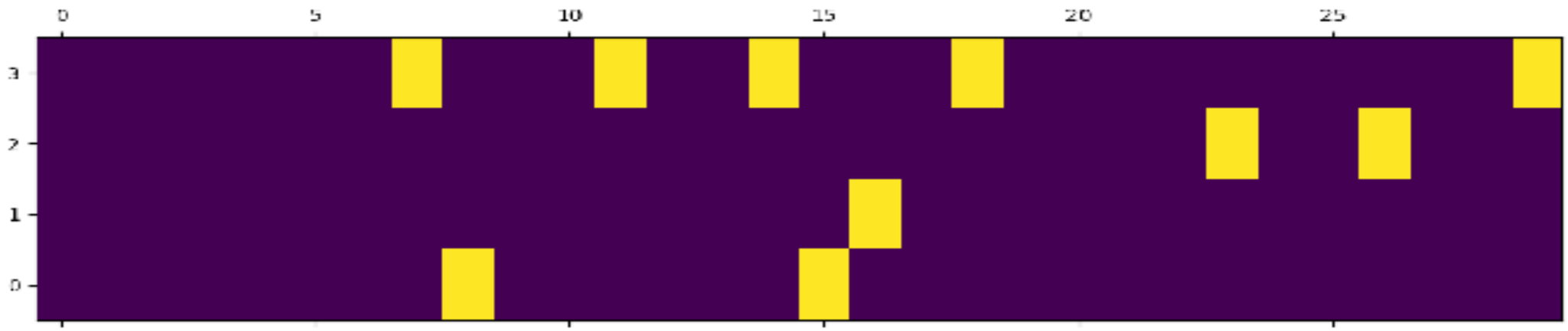
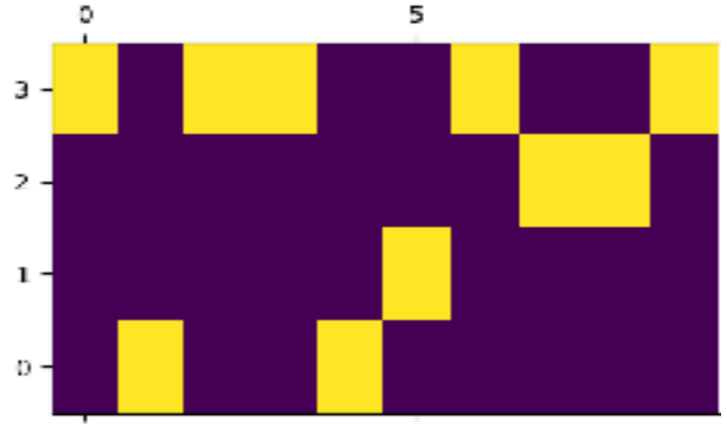
Canonical Example of Alignment/Selection Problem

Input/Attended



Target



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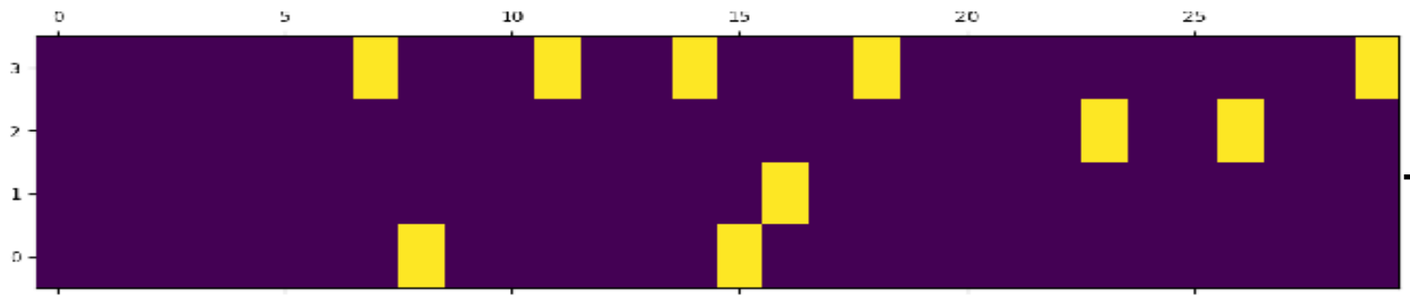
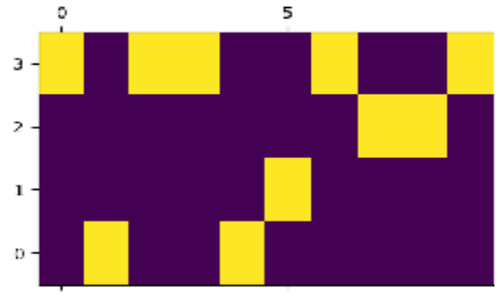
Sequence-to-Sequence



LSTM-Encoder

Encoding

LSTM-Decoder



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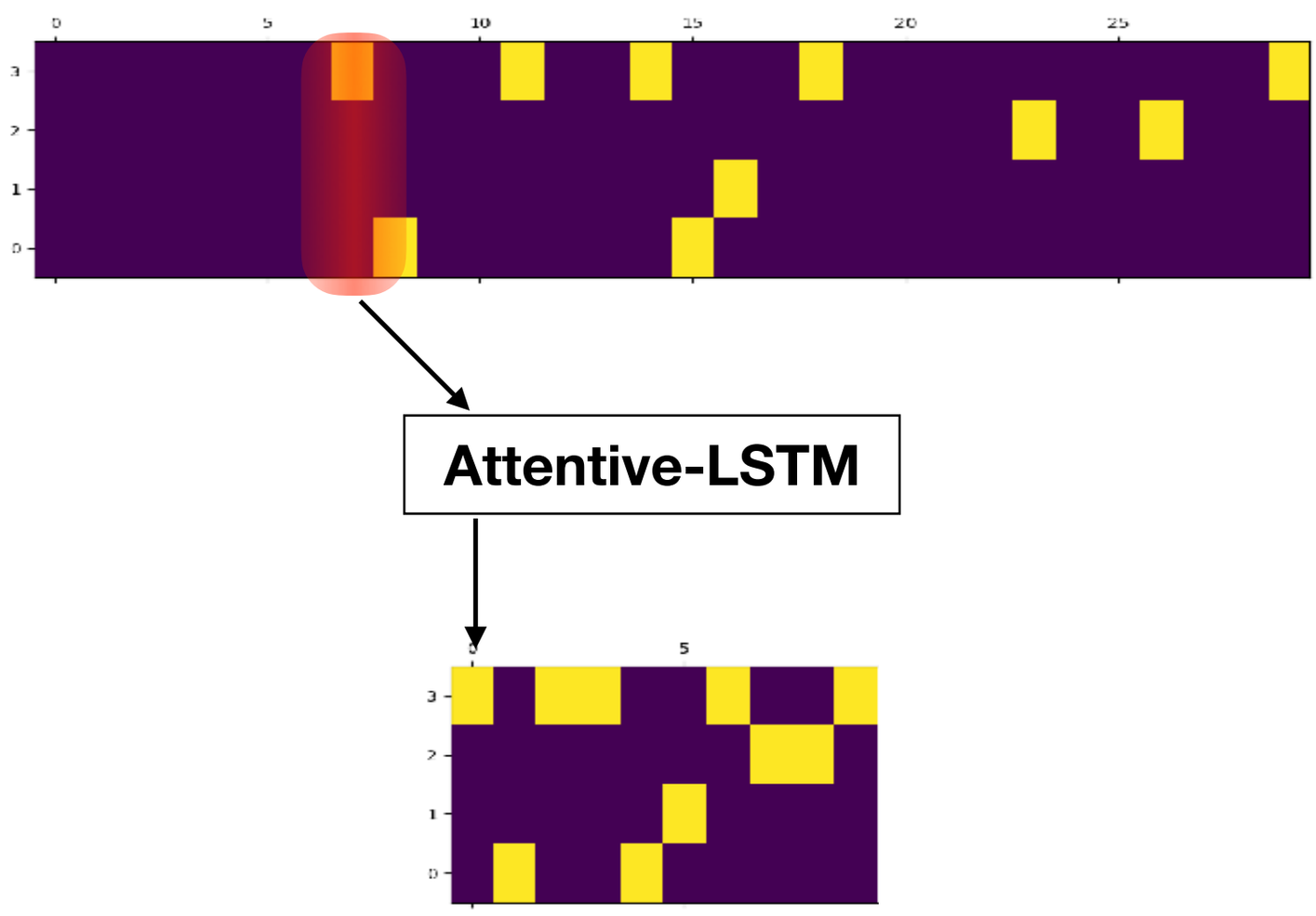
Attention



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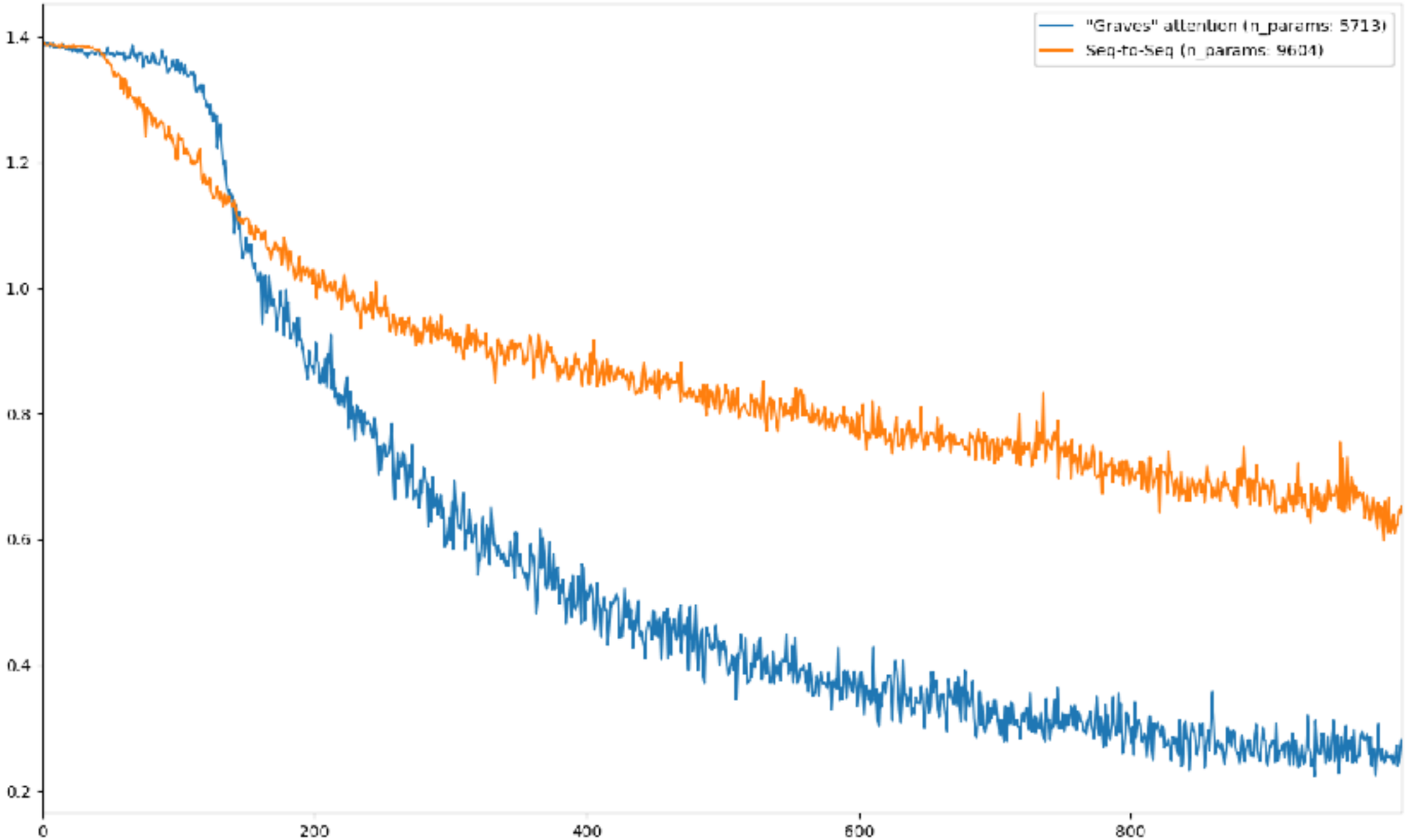
Seq-to-Seq vs Attention

attended sequence length: 30, target sequence length: 10



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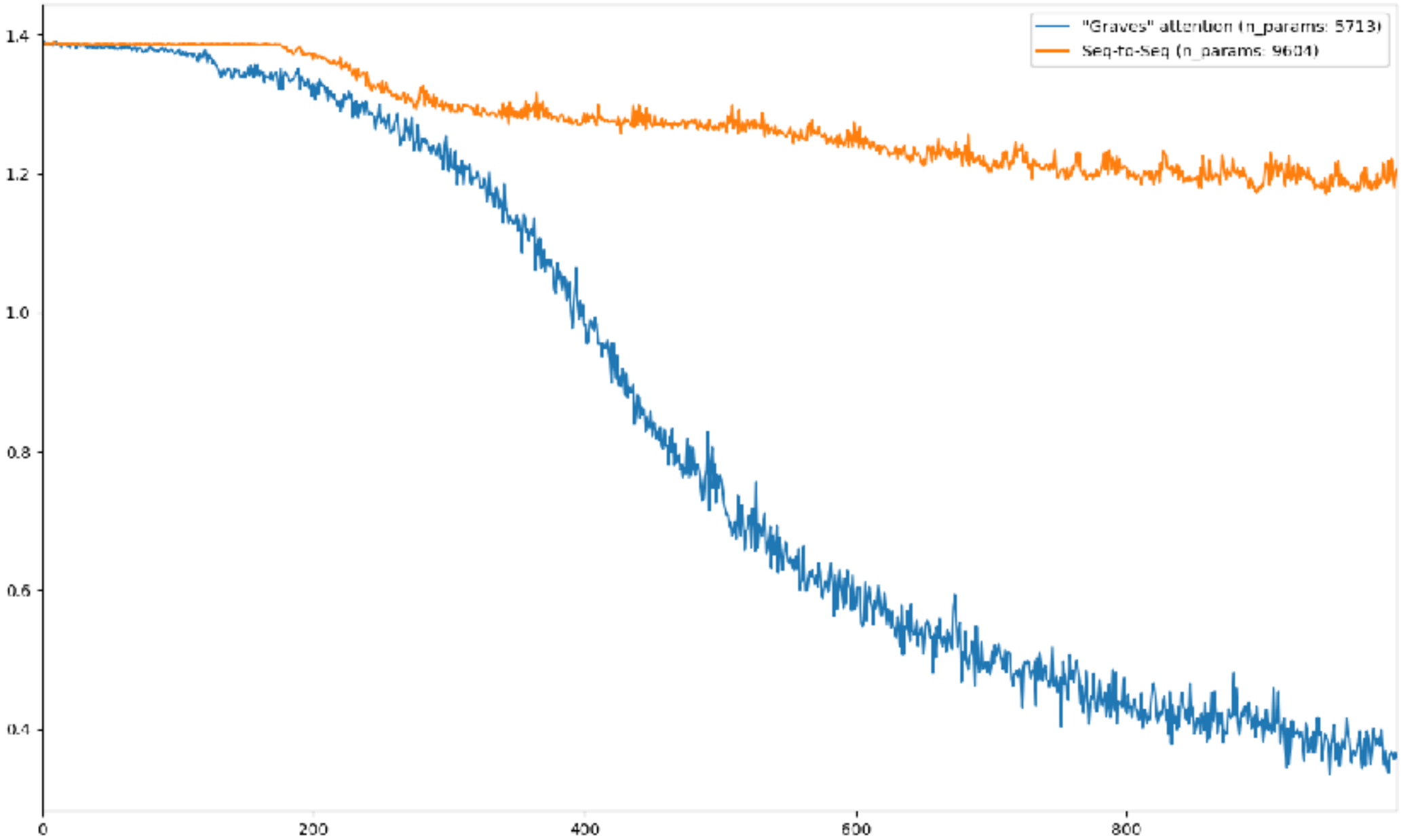
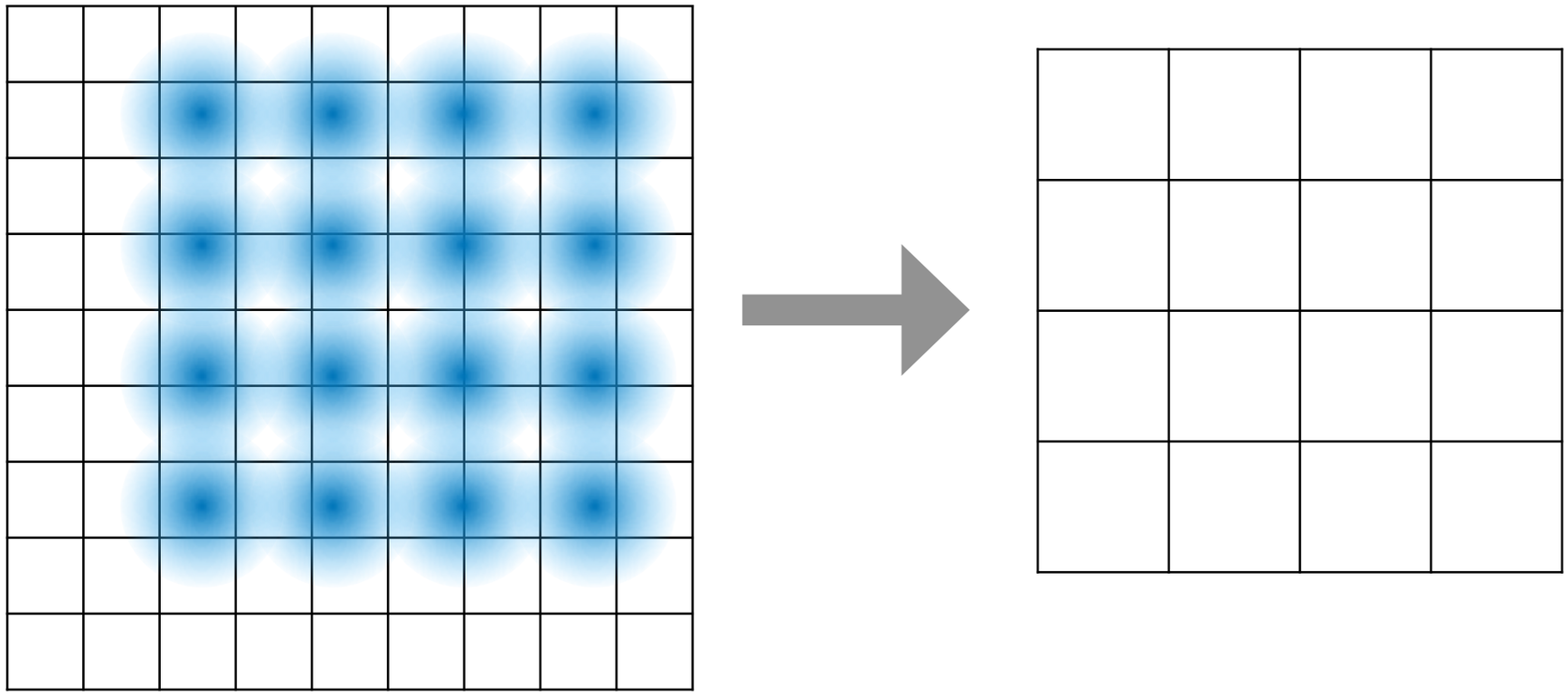
Seq-to-Seq vs Attention

attended sequence length: 60, target sequence length: 20



Spatial Attention: 2D

“zoom and shift” focus



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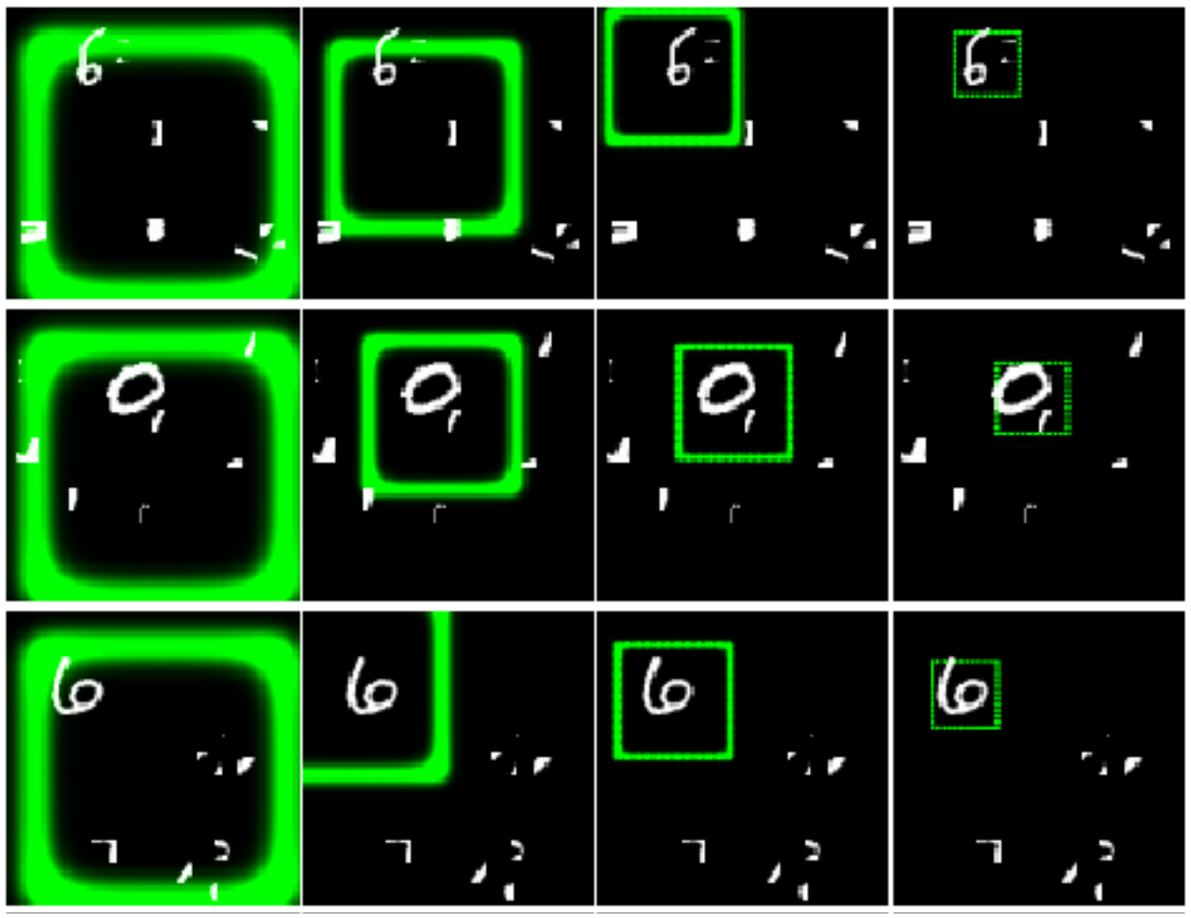
Spatial Attention: 2D

“zoom and shift” focus



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Spatial Attention: 2D

"zoom and shift" focus

A woman is throwing a **frisbee** in a park.

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Differentiability

- Very convenient - we can train with SGD and Backprop as usual
- Obvious limitations regarding efficiency and size of the attended

Beyond Spatial Attention

- With attention, we can selectively make use of specific pieces of information when we need it.
- “Information retrieval problems”
- Add support for *storing* information at certain locations -> “Neural Touring Machine”

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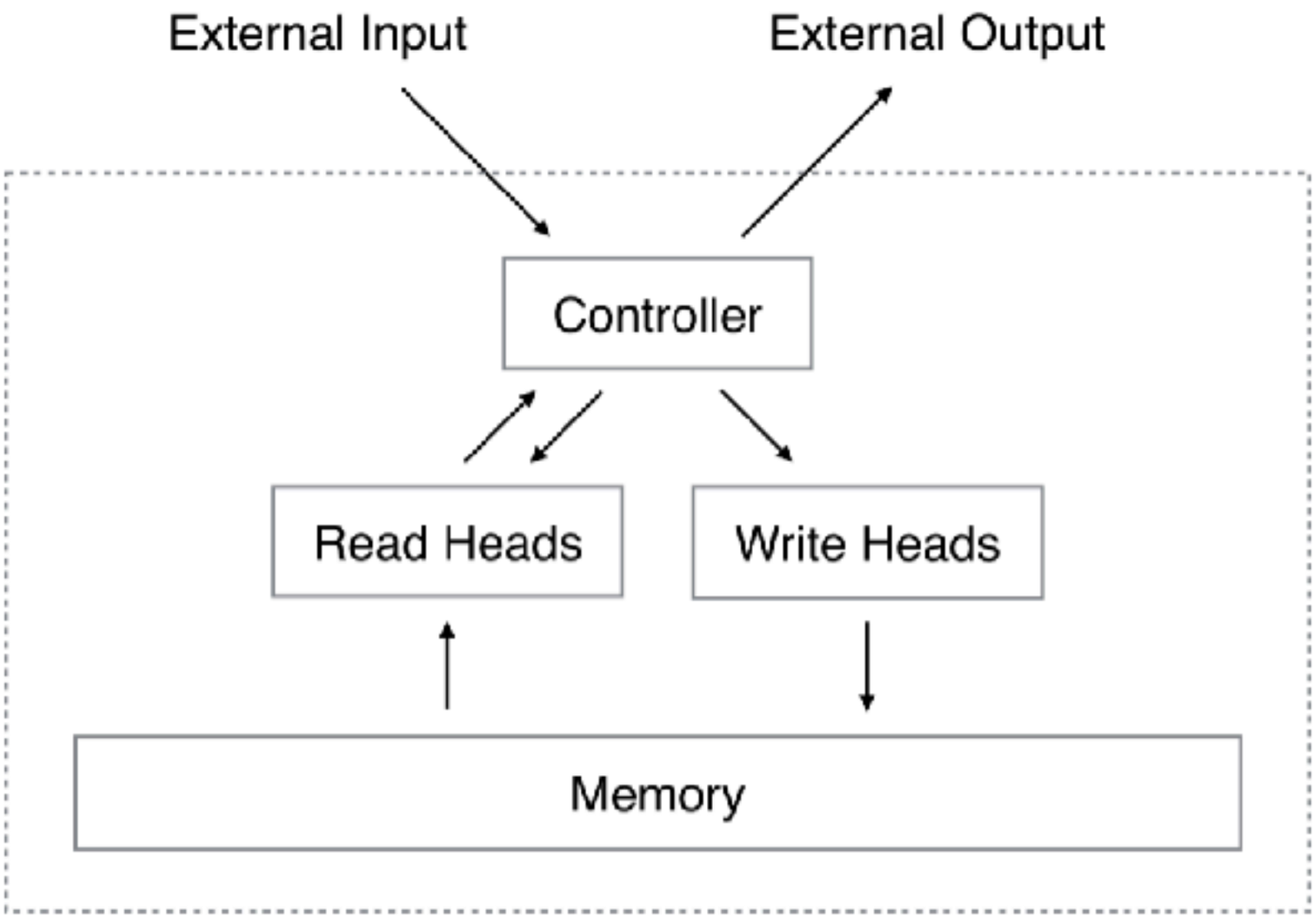
Neural Touring Machine



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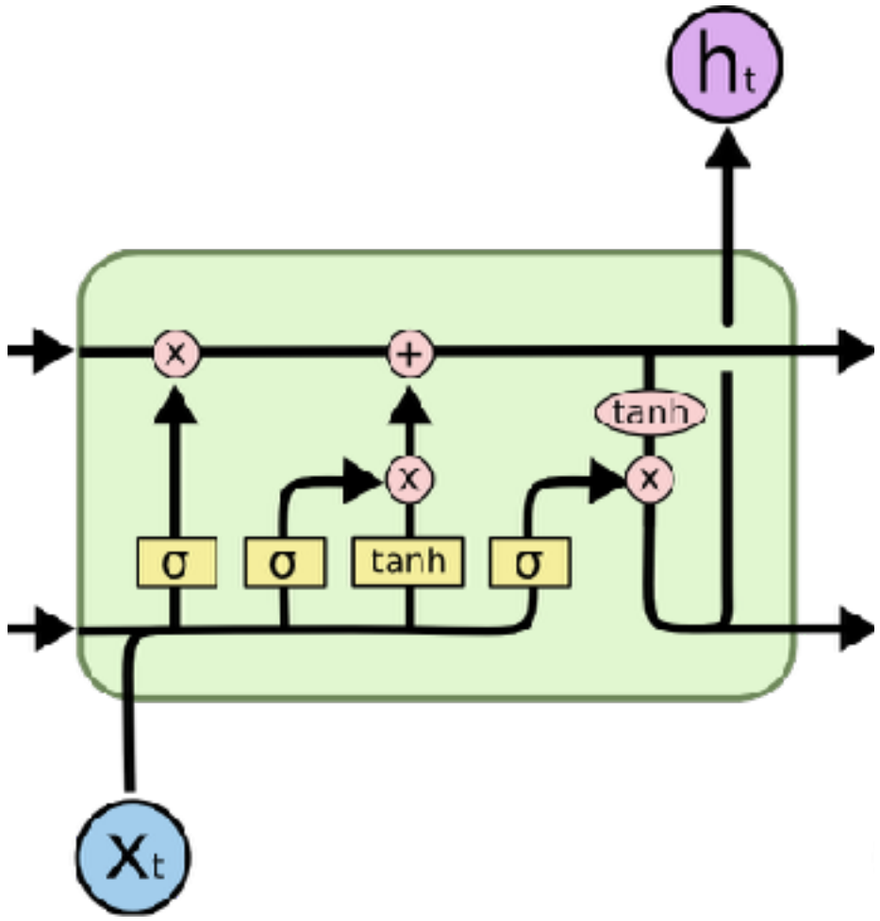
Neural Touring Machine

Comparison LSTM

- Similar concept
- NTM considerable more sophisticated (tailored) read/ write mechanisms
- size of NTM memory can be increase without increasing number of parameters to learn (grows quadratically in LSTM)



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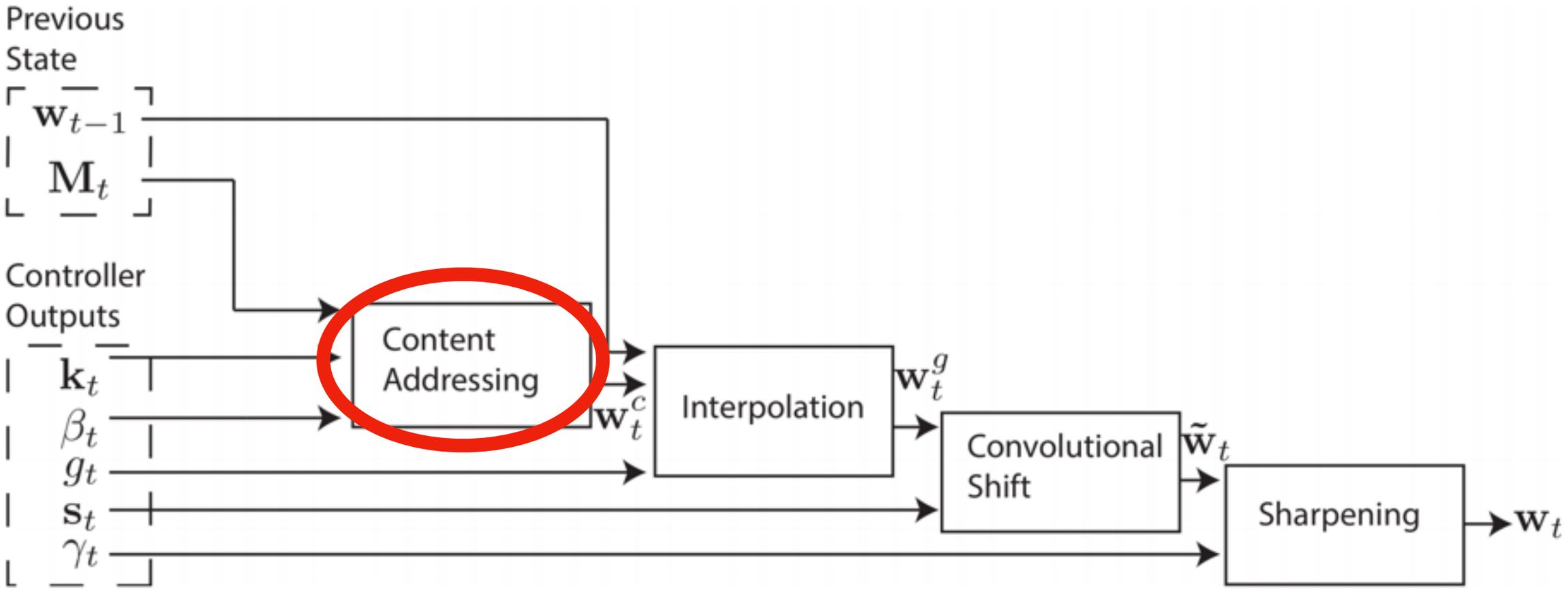
Neural Touring Machine



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Questions/Discussion

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