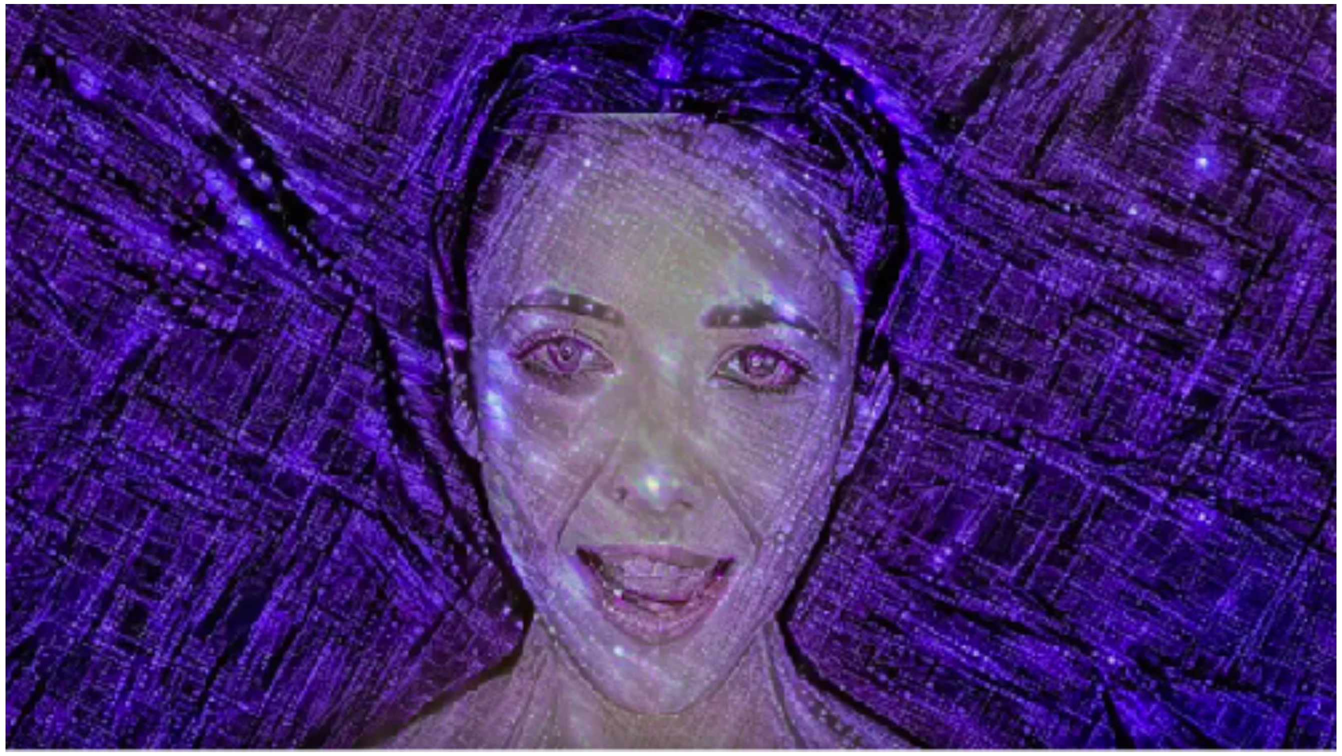
RNN's Applications

Pramod Kompalli
OLA

Sunspring

https://arstechnica.com/gaming/2016/06/an-ai-wrote-this-movie-and-its-strangely-moving/

Generating Music



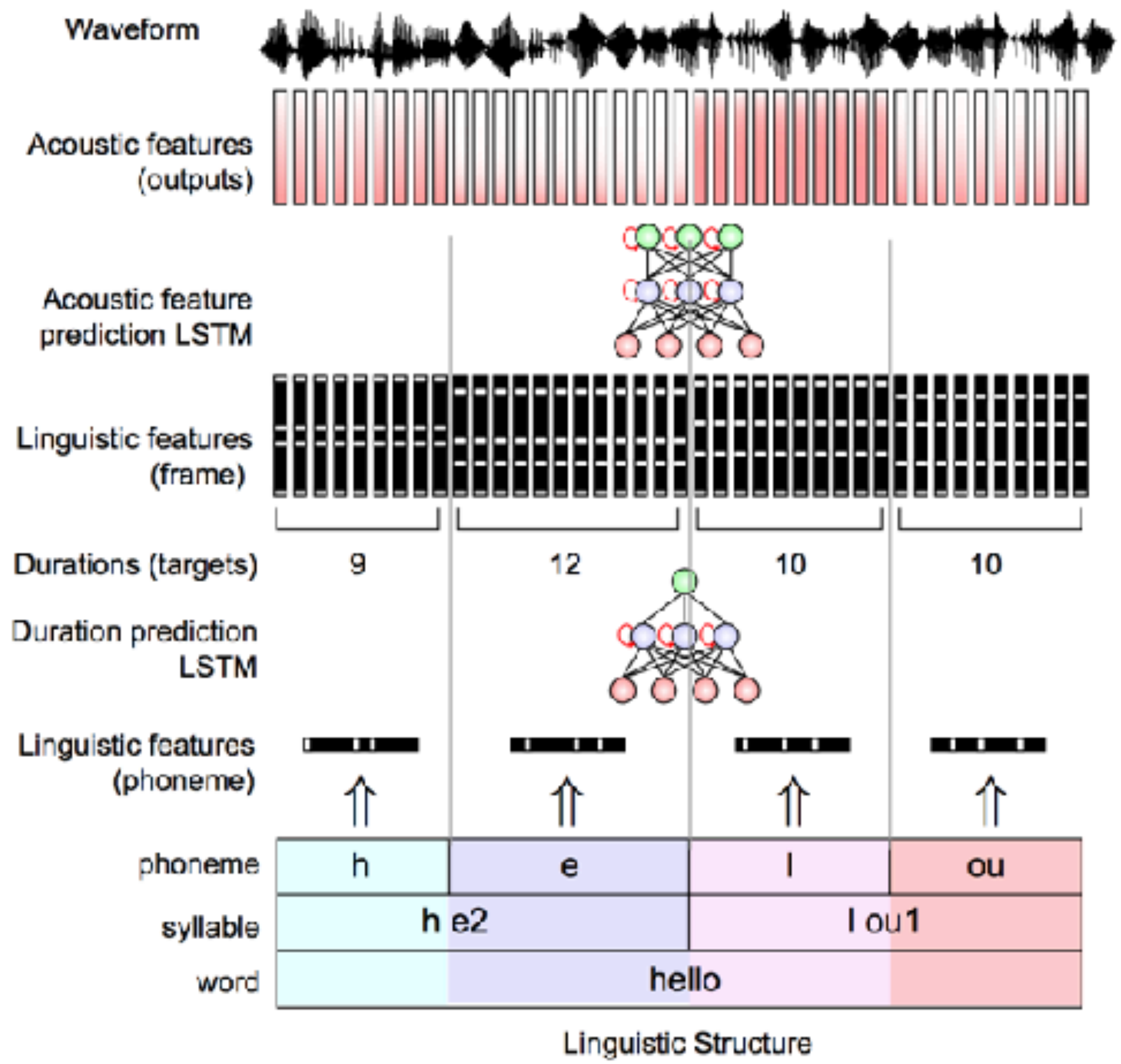
Break Free

https://www.youtube.com/watch?v=XUs6CznN8pw

Deep Music
@ Alexa

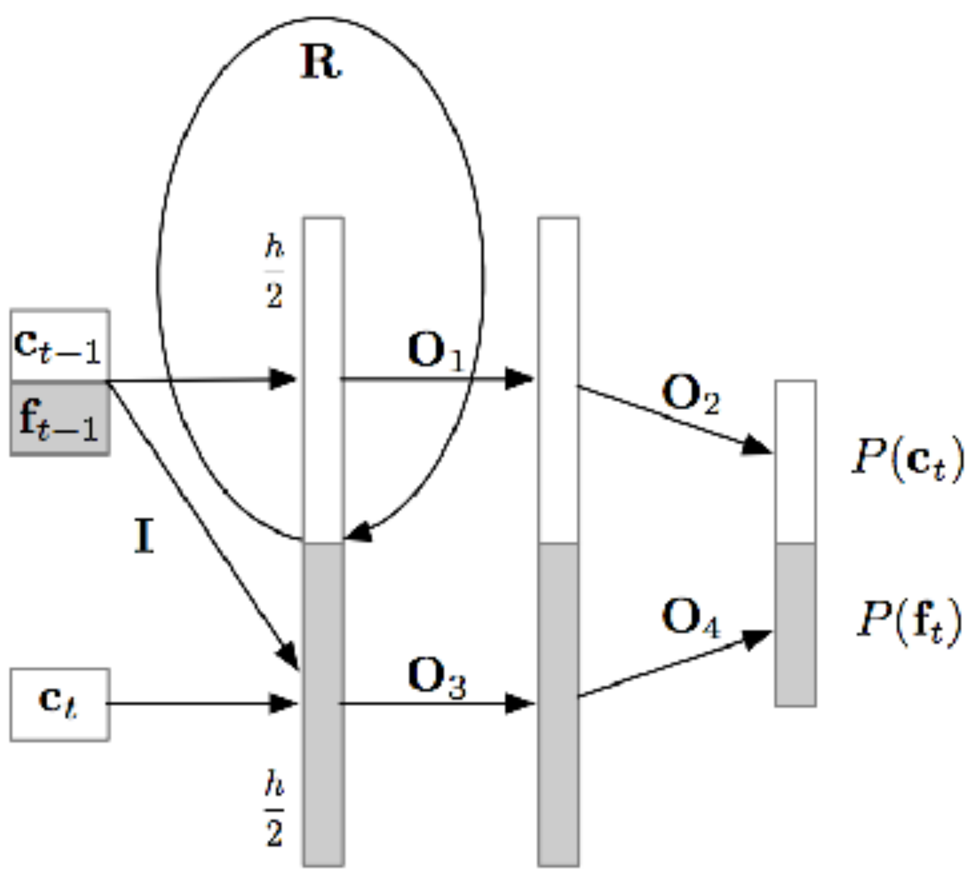
Generating Speech

Generating Speech



Zen et al., Fast, compact, and high quality LSTM-RNN based statistical parametric speech synthesizers for mobile devices, Interspeech, 2016.

Generating Speech

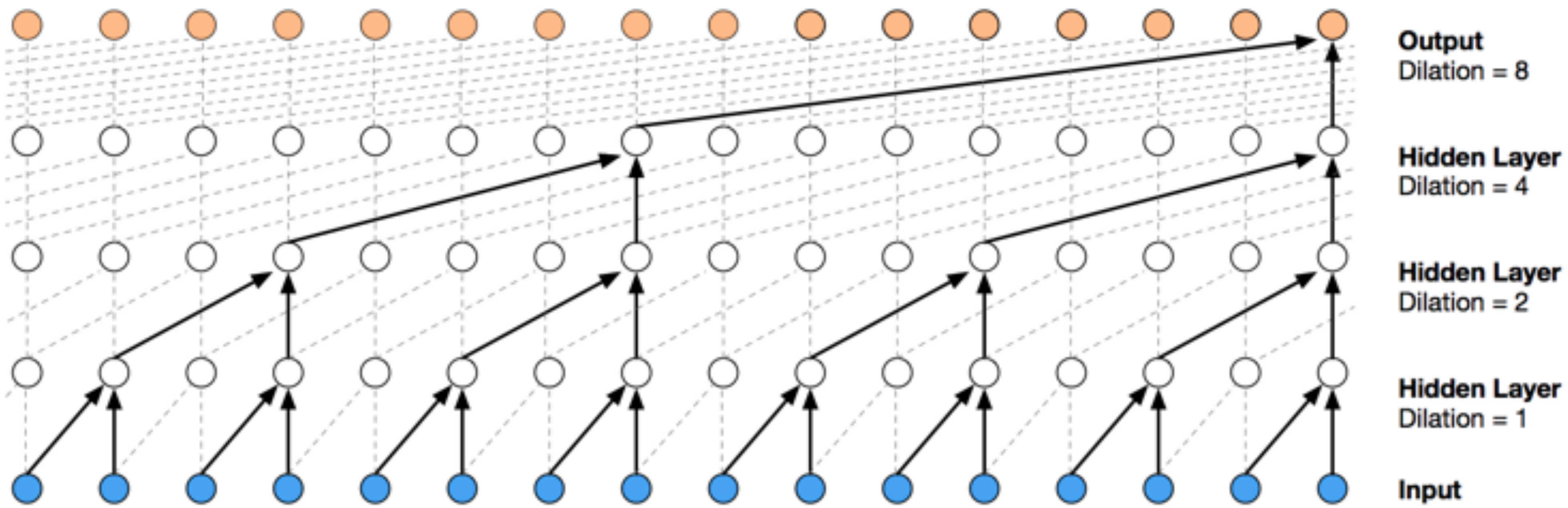


Dual Softmax

c - coarse bits of audio
f - fine bits of audio

Kalchbrenner et al., Efficient Neural Audio Synthesis, ICML 2018

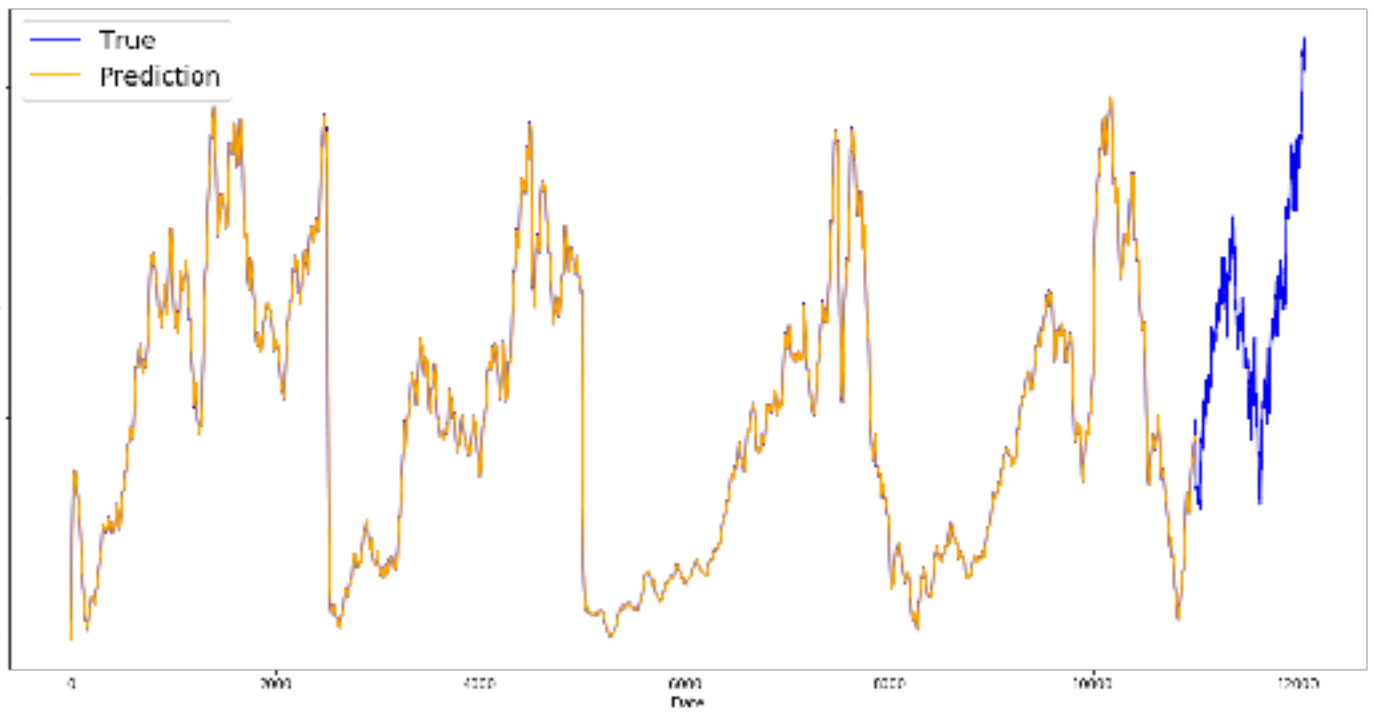
Generating Speech



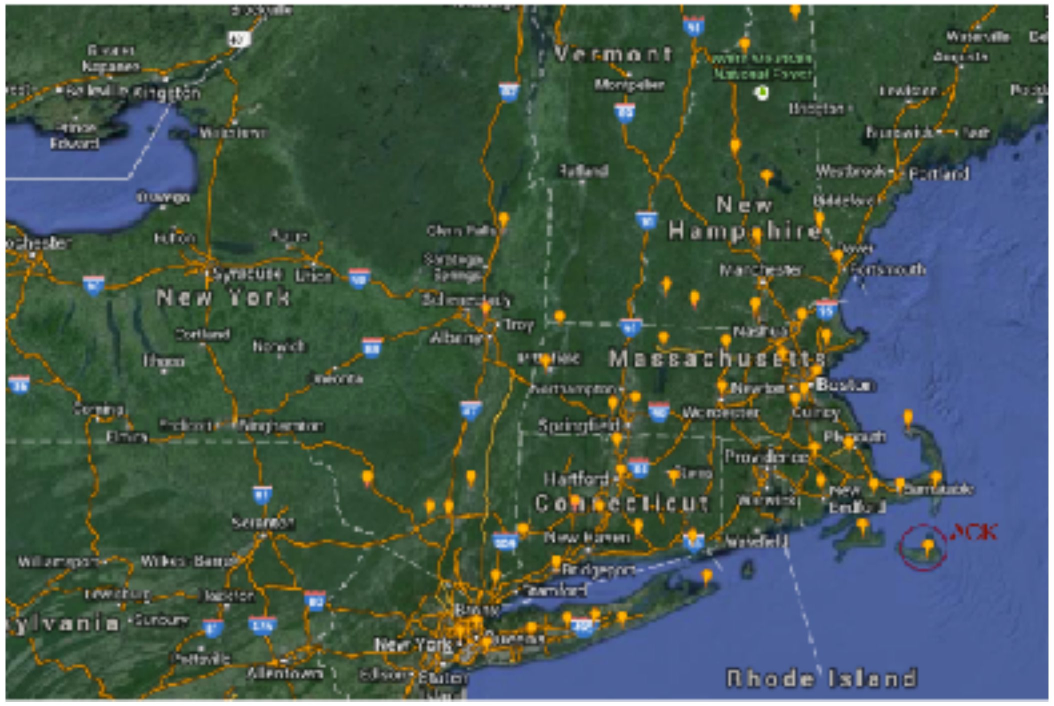
Dilated Convolutions

van den Oord et al., WaveNet: A Generative Model for Raw Audio, *arXiv:1609.03499*

Time-Series Predictions



Stock Market Prediction

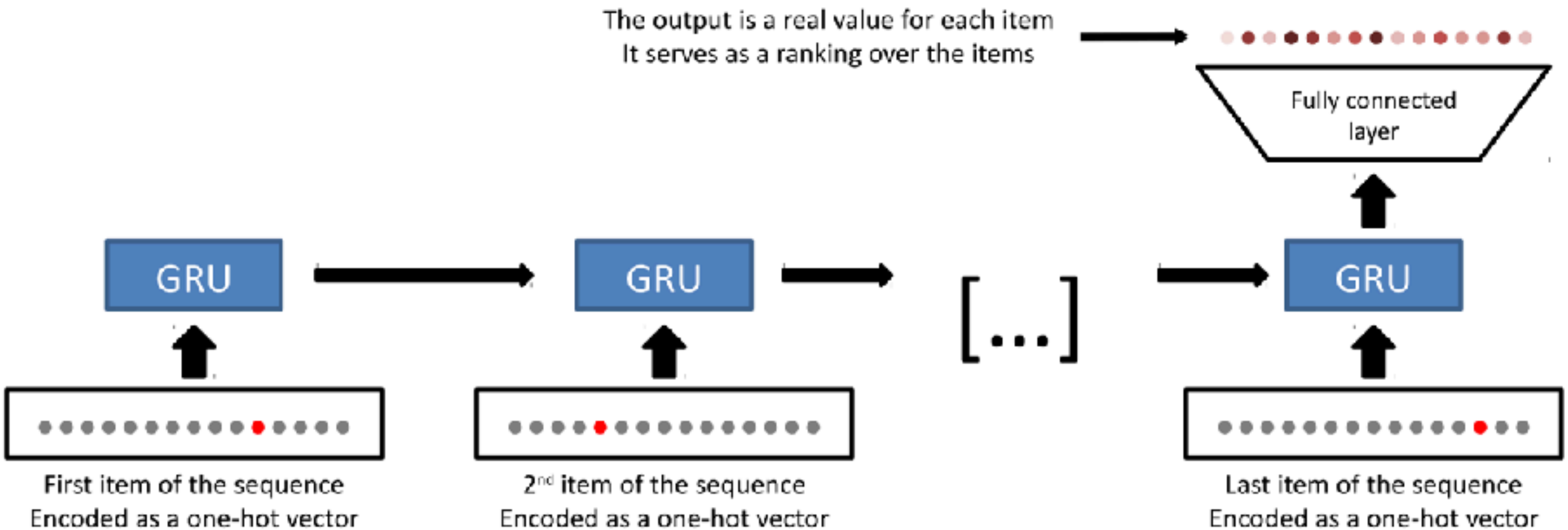


Wind Prediction

Nelson et al., Stock market's price movement prediction with LSTM neural networks, IJCNN 2017

Ghaderi et al., Deep Forecast: Deep Learning-based Spatio-Temporal Forecasting, ICML Time series Workshop 2017

Product Recommendation



Devooght & Bersini, Long and Short-Term Recommendations with Recurrent Neural Networks, UMAP 2017

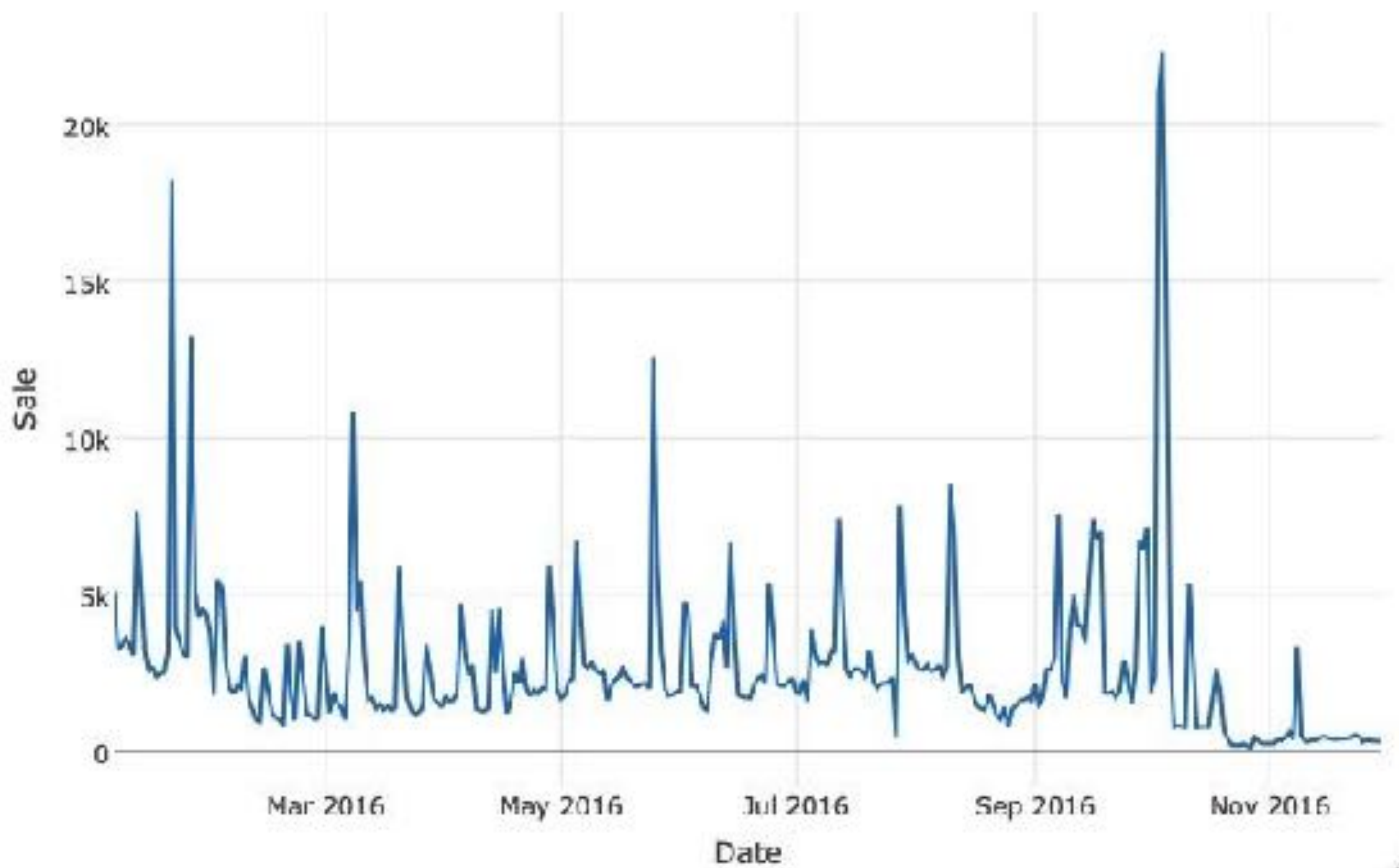
Forecasting in eCommerce

Demand Forecasting

Seasonal
Demand/Supply

Demand & Supply Forecasting
Consequently Pricing

Demand Forecasting @ Flipkart

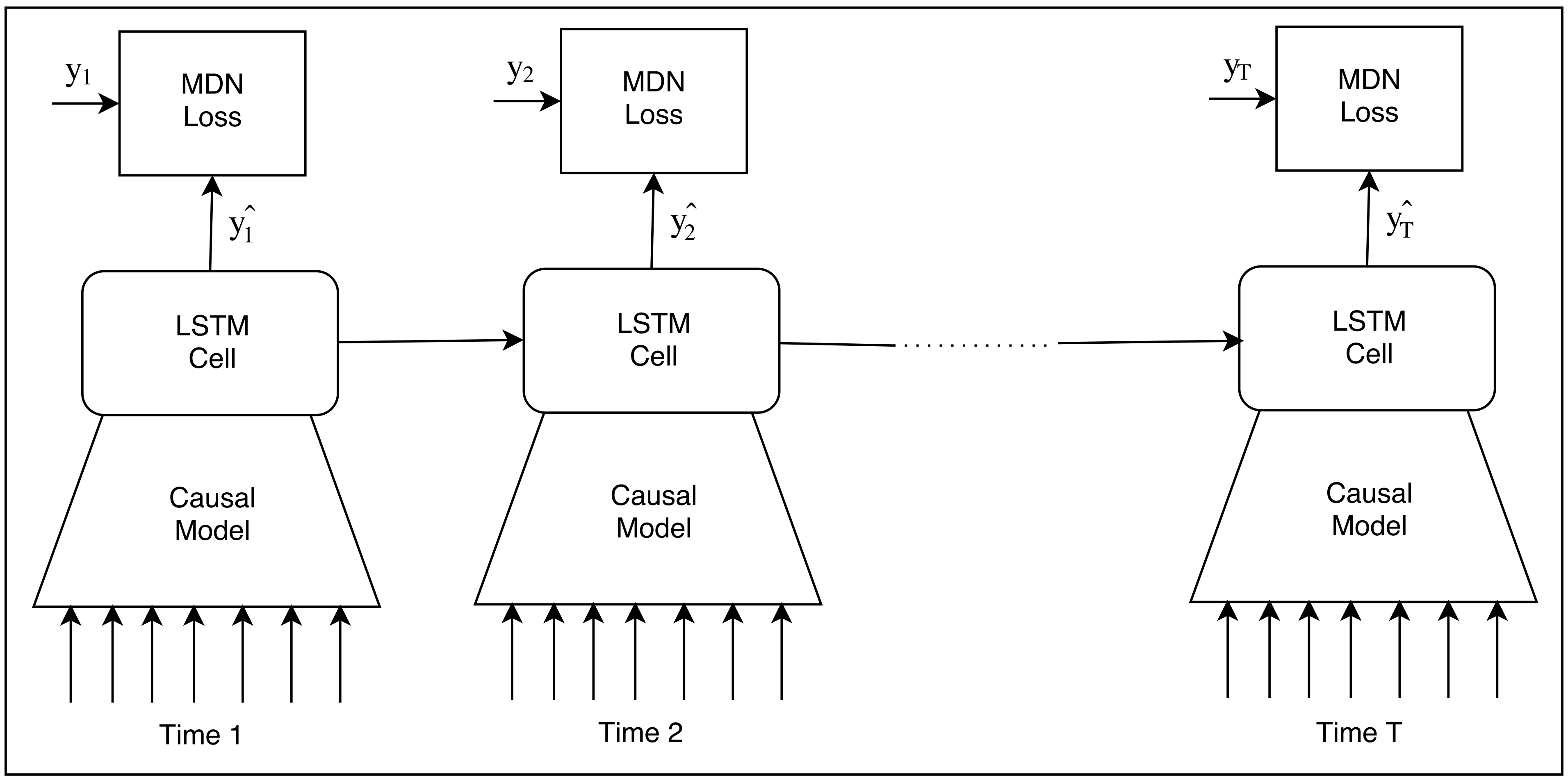


SAMSUNG 32GB Memory Card

- High Variance
- "Causal" factors.
- Dependence on Other products - Upsell & Cannibalisation
- New products have NO history
- Imbalanced data

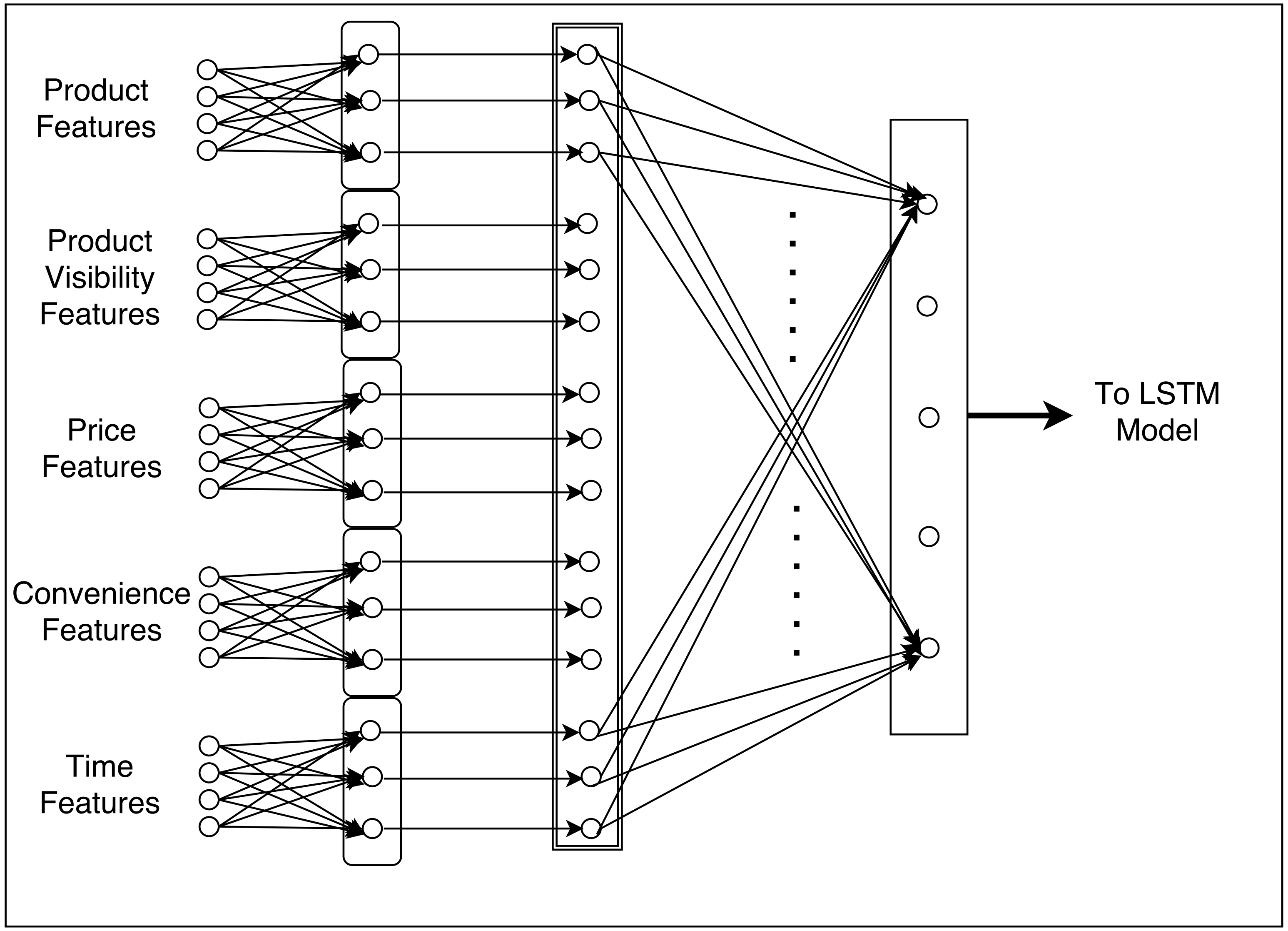
Mukherjee et al., ARMDN: Associative and Recurrent Mixture Density Networks for eRetail Demand Forecasting, *arXiv:1803.03800*

Demand Forecasting @ Flipkart



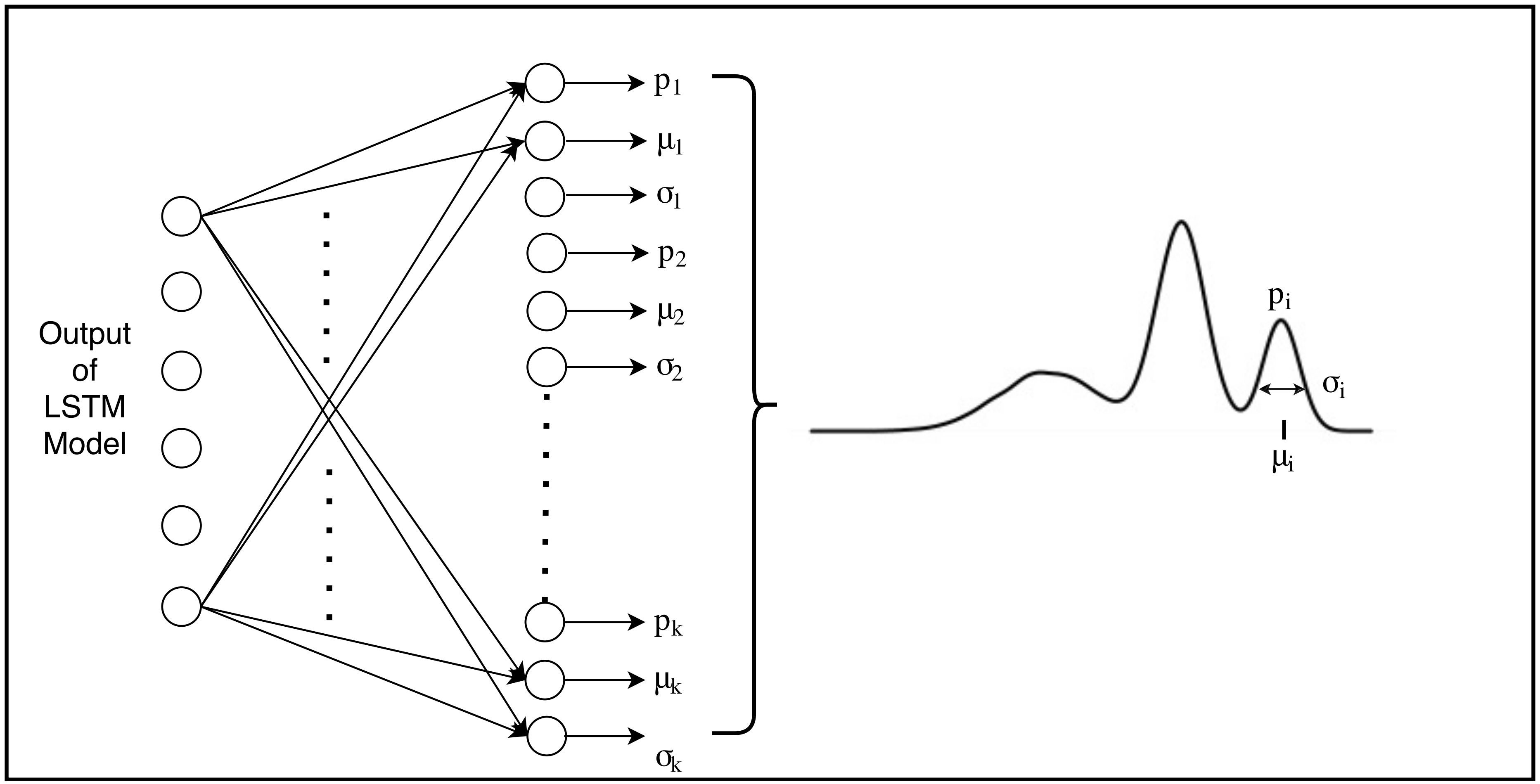
Mukherjee et al., ARMDN: Associative and Recurrent Mixture Density Networks for eRetail Demand Forecasting, *arXiv:1803.03800*

Demand Forecasting @ Flipkart



Mukherjee et al., ARMDN: Associative and Recurrent Mixture Density Networks for eRetail Demand Forecasting, *arXiv:1803.03800*

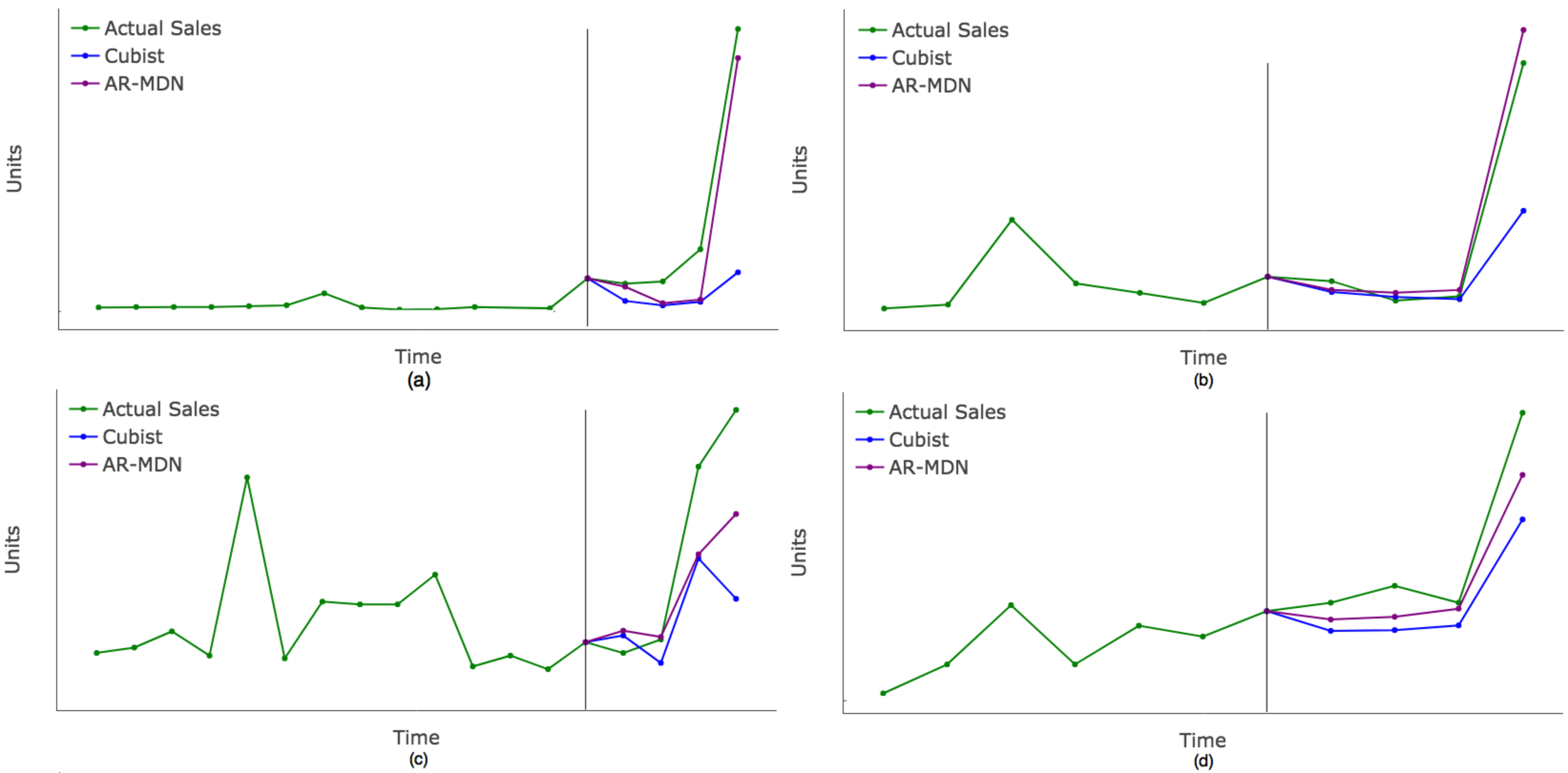
Demand Forecasting @ Flipkart



$$l_{\mathrm{MDN}}(y|\theta) = -\frac{1}{T}\sum_{j=1}^{T}\log\sum_{k=1}^{K}\frac{p_k}{\sqrt{2\pi\sigma_k^2}}exp\left(-\frac{(y_j-\mu_k)^2}{2\sigma_k^2}\right)$$

Mukherjee et al., ARMDN: Associative and Recurrent Mixture Density Networks for eRetail Demand Forecasting, *arXiv:1803.03800*

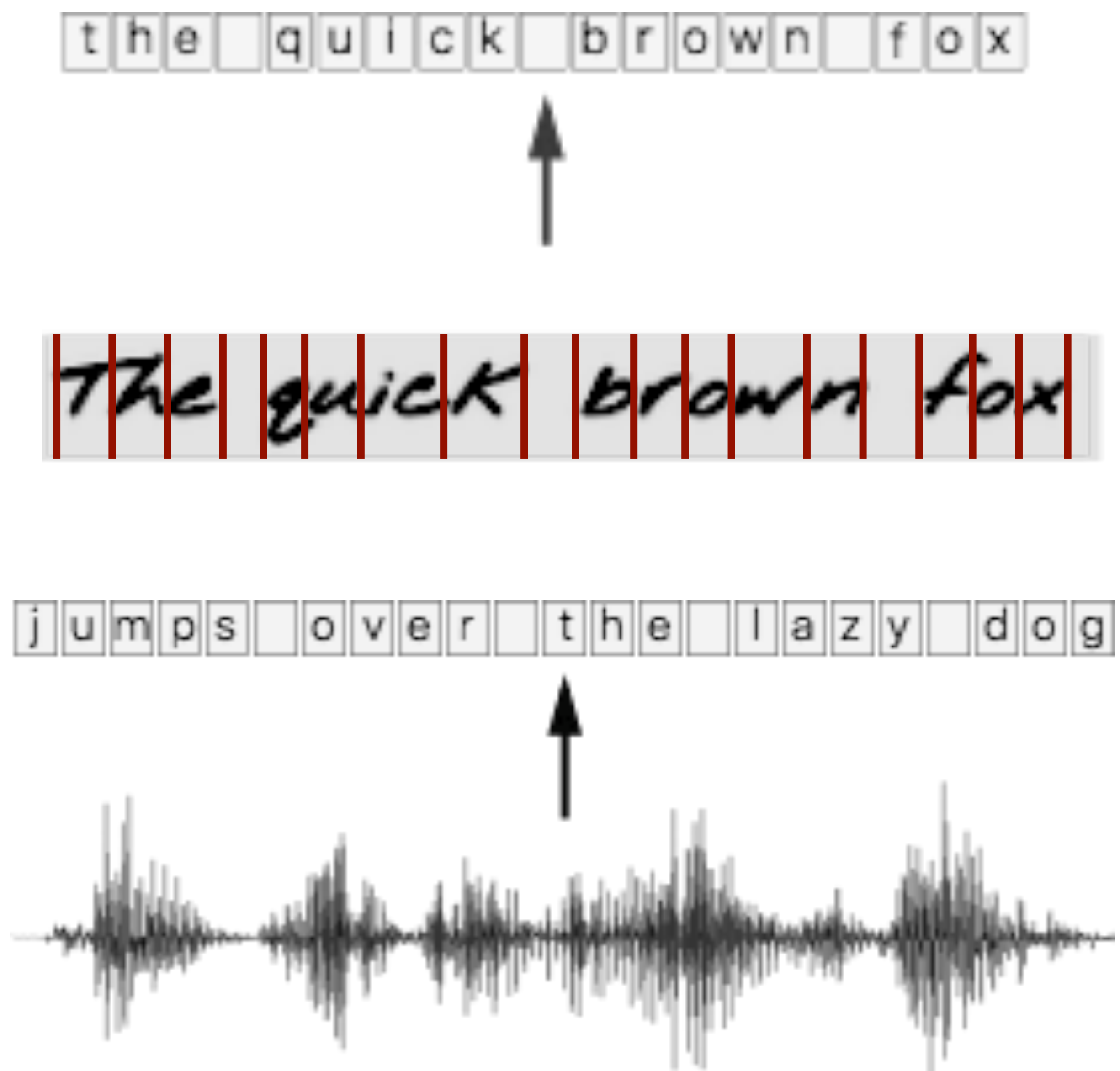
Demand Forecasting @ Flipkart



wMAPE: 32 (ARMDN) vs 40 (Cubist)

Mukherjee et al., ARMDN: Associative and Recurrent Mixture Density Networks for eRetail Demand Forecasting, *arXiv:1803.03800*

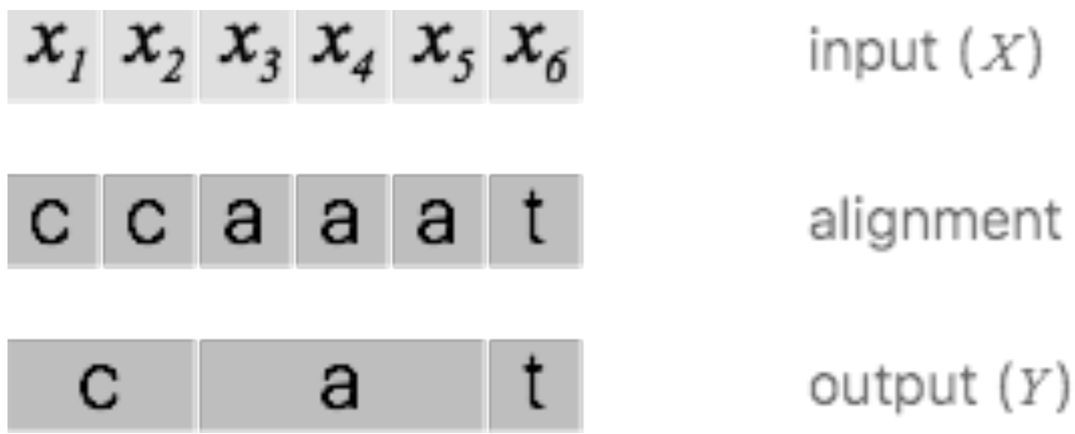
Sequence Alignment

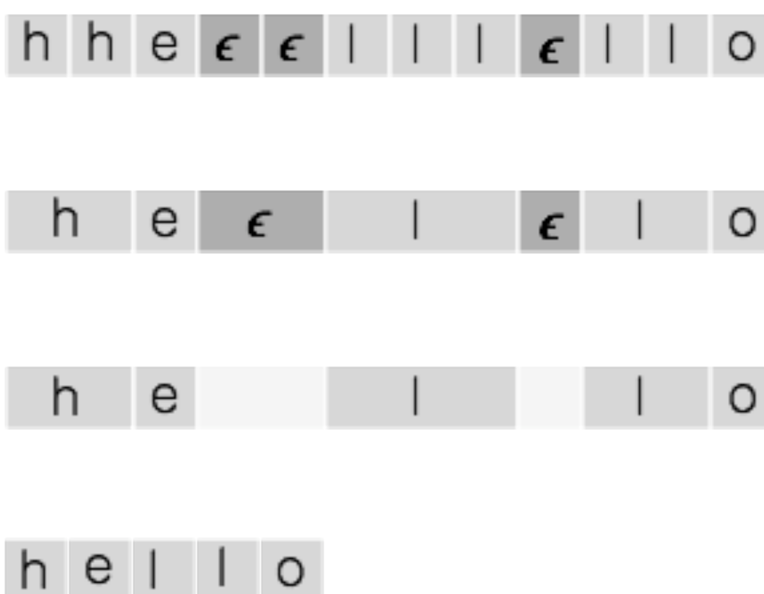


S2S Challenges

- Input & Output need not be of same length
- Input & Output need not be aligned
- Input & Output might have different order (before/after)
- Current output depends on previous output
- Dependencies could be of variable length

Connectionist Temporal Classification (CTC)



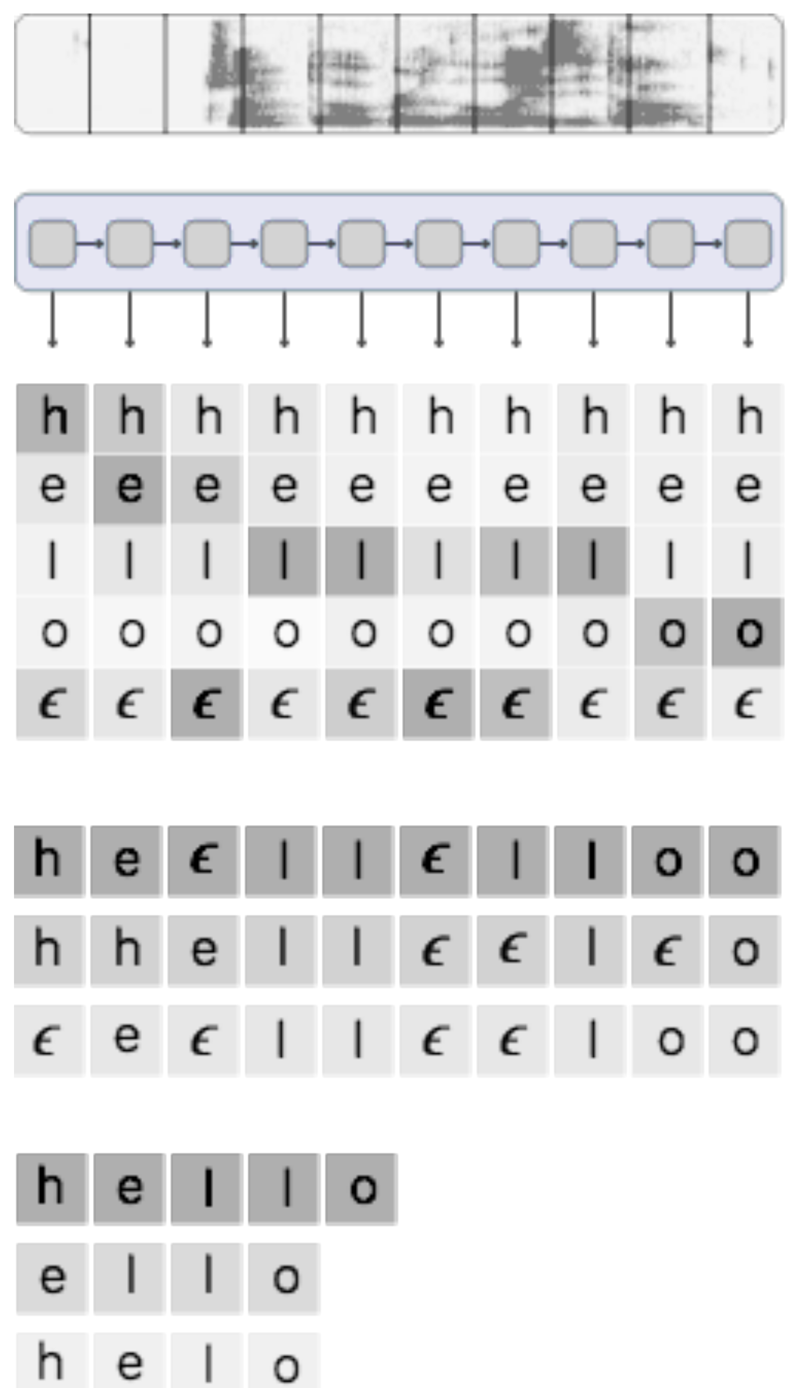


First, merge repeat characters.

Then, remove any ϵ tokens.

The remaining characters are the output.

Connectionist Temporal Classification (CTC)



We start with an input sequence, like a spectrogram of audio.

The input is fed into an RNN, for example.

The network gives $p_t(a \mid X)$, a distribution over the outputs $\{h, e, l, o, \epsilon\}$ for each input step.

With the per time-step output distribution, we compute the probability of different sequences

By marginalizing over alignments, we get a distribution over outputs

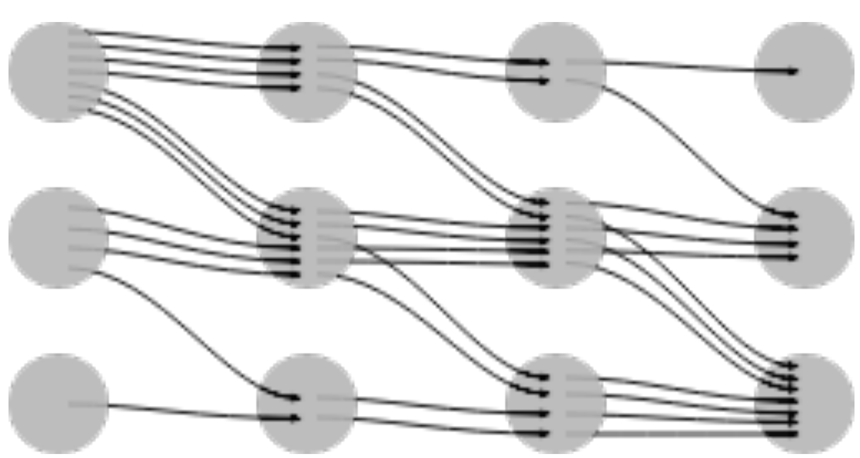
Connectionist Temporal Classification (CTC)

$$p(Y \mid X) \quad = \quad \sum_{A \in \mathcal{A}_{X,Y}} \quad \prod_{t=1}^{T} p_t(a_t \mid X)$$

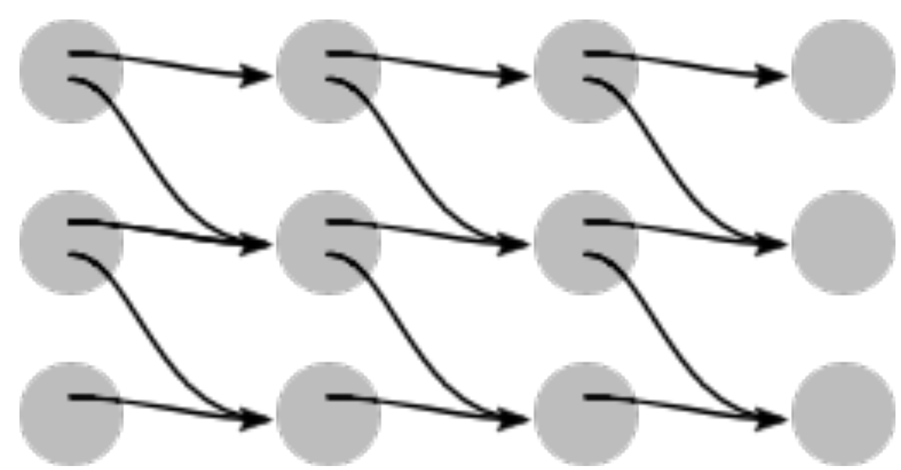
The CTC conditional **probability**

marginalizes over the set of valid alignments

computing the **probability** for a single alignment step-by-step.

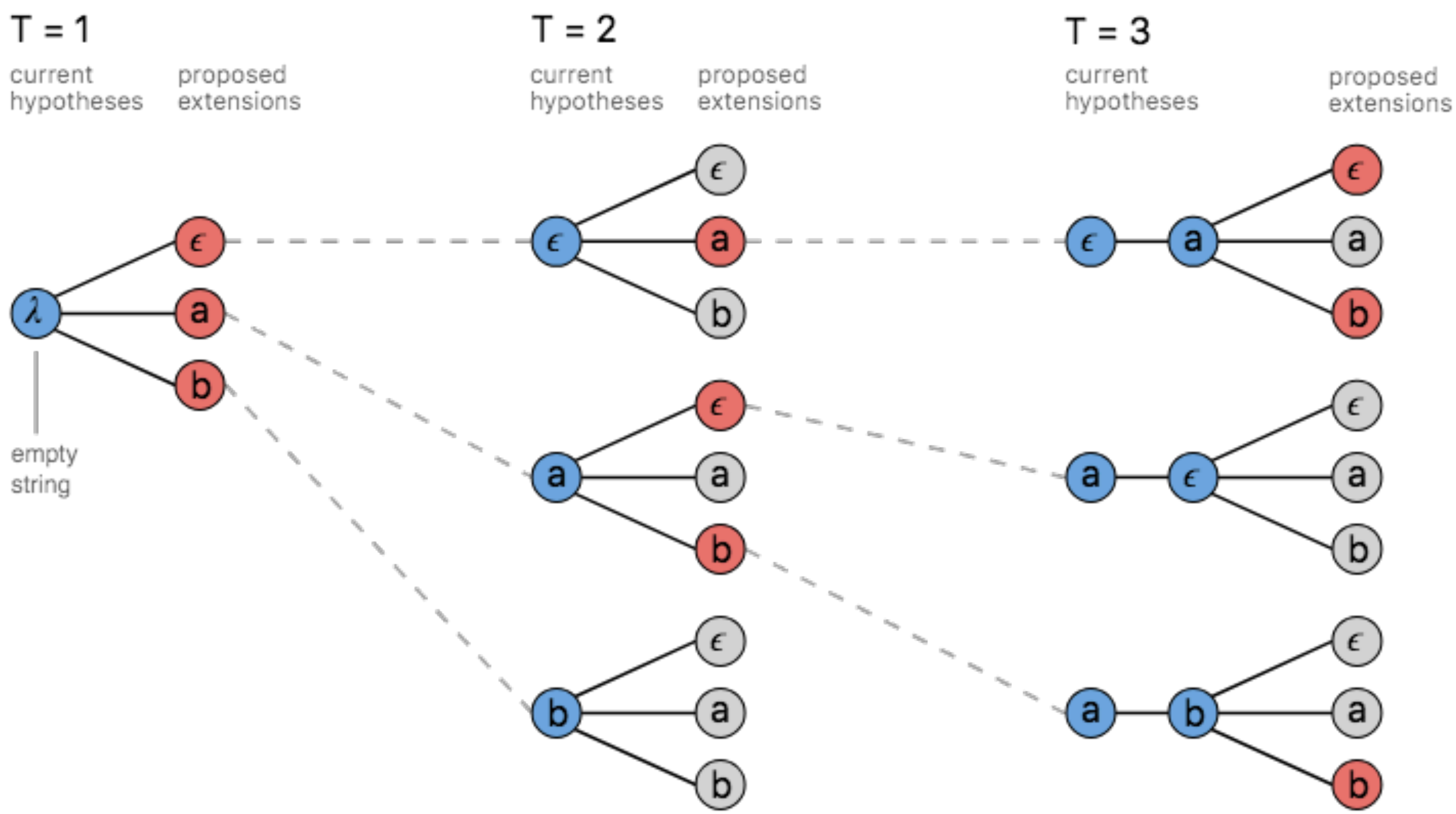


Full-fledged Search



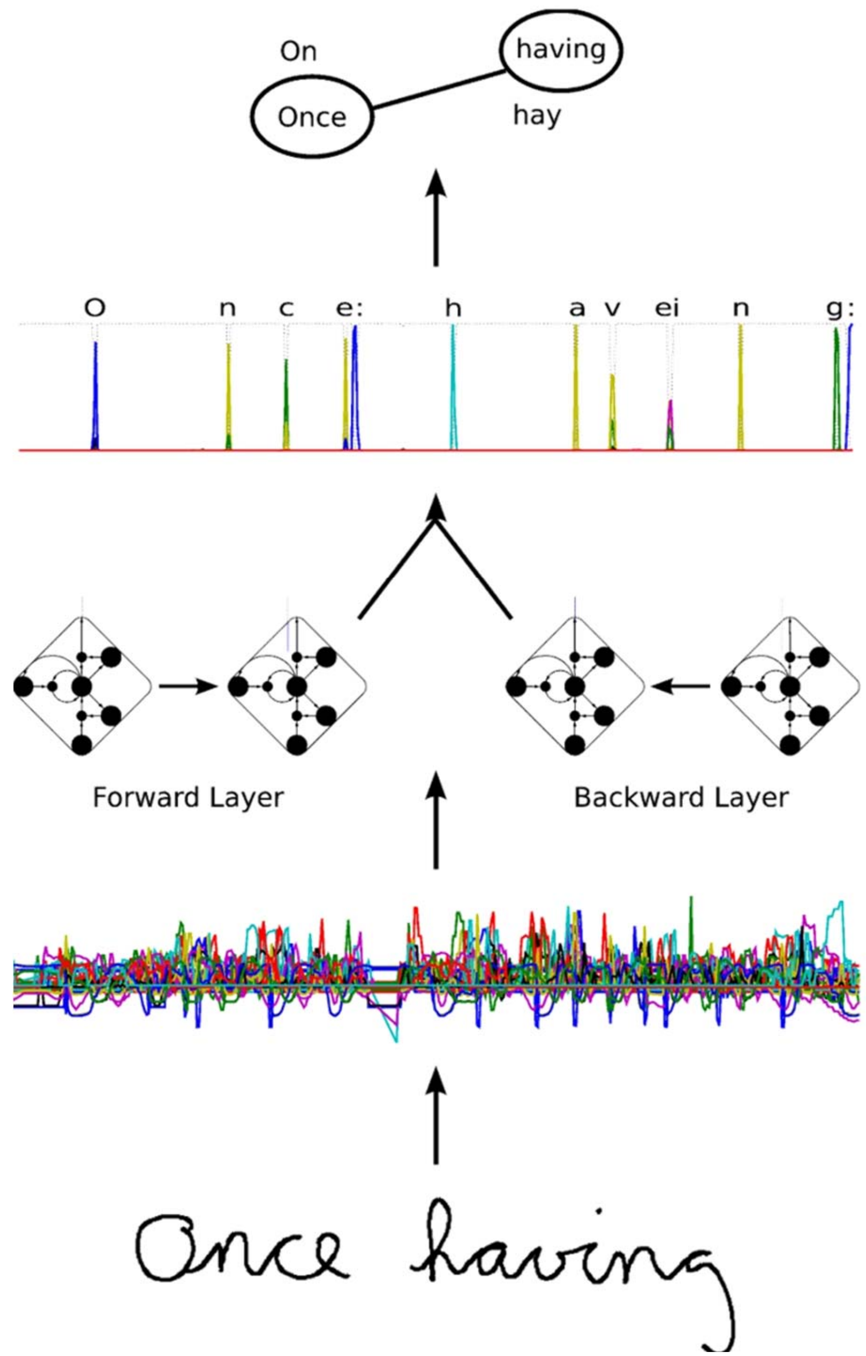
Dynamic Programming

Connectionist Temporal Classification (CTC)



Beam Search

Handwriting Recognition



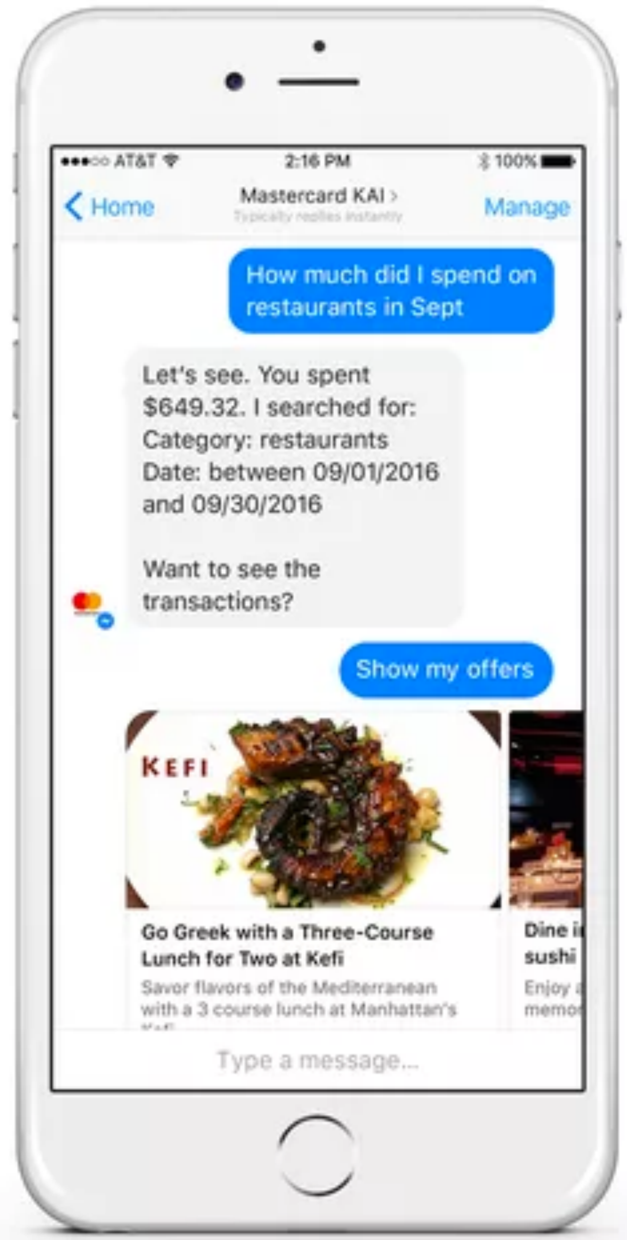
Picture courtesy: Marcus Liwicki

Chat Bots

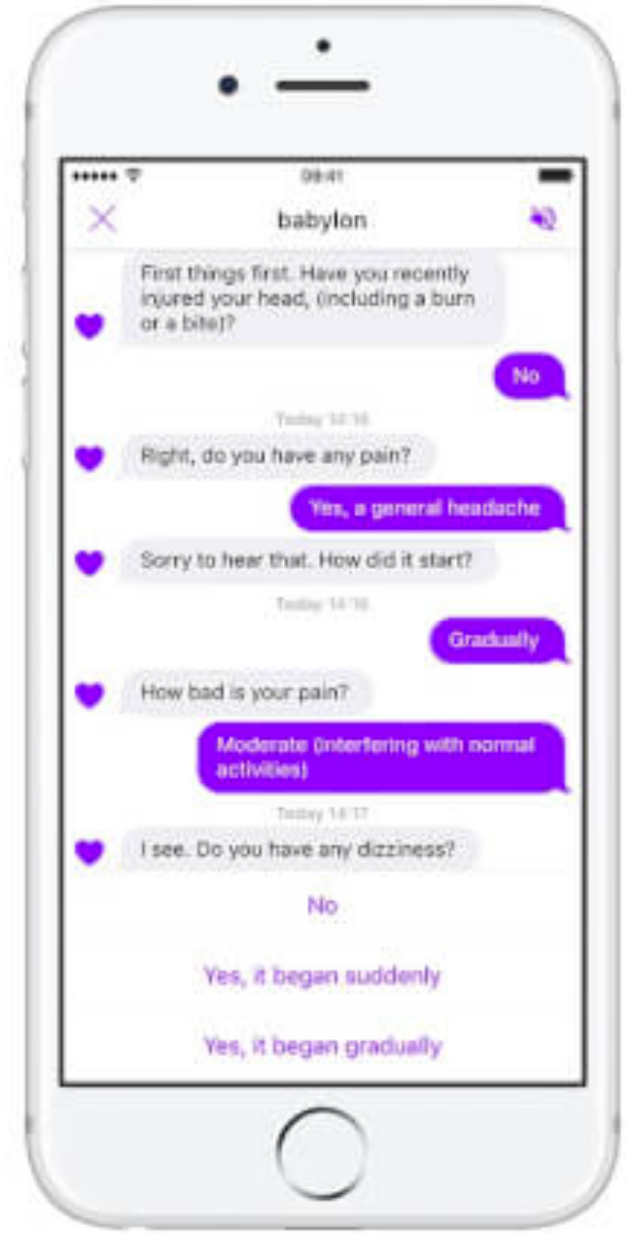

Eliza (1966)
> Hello, I am Eliza.
* Hey!
> Don't you ever say Hello?
* Hello!
> How are you today.. What would you like to discuss?
* I'm depressed.
> Do you enjoy being depressed?
* No, I don't.
> Why no?
* Because I want to be happy.
> Why do you want to be happy?
* Because I'm tired od being depressed.
> That is quite interesting.
* I'm not sure

Chat Bots

eCommerce



Financial



Healthcare

Chat Bots

INPUT: *Hi!*

OUTPUT: *Hi!*

INPUT: *How are you?*

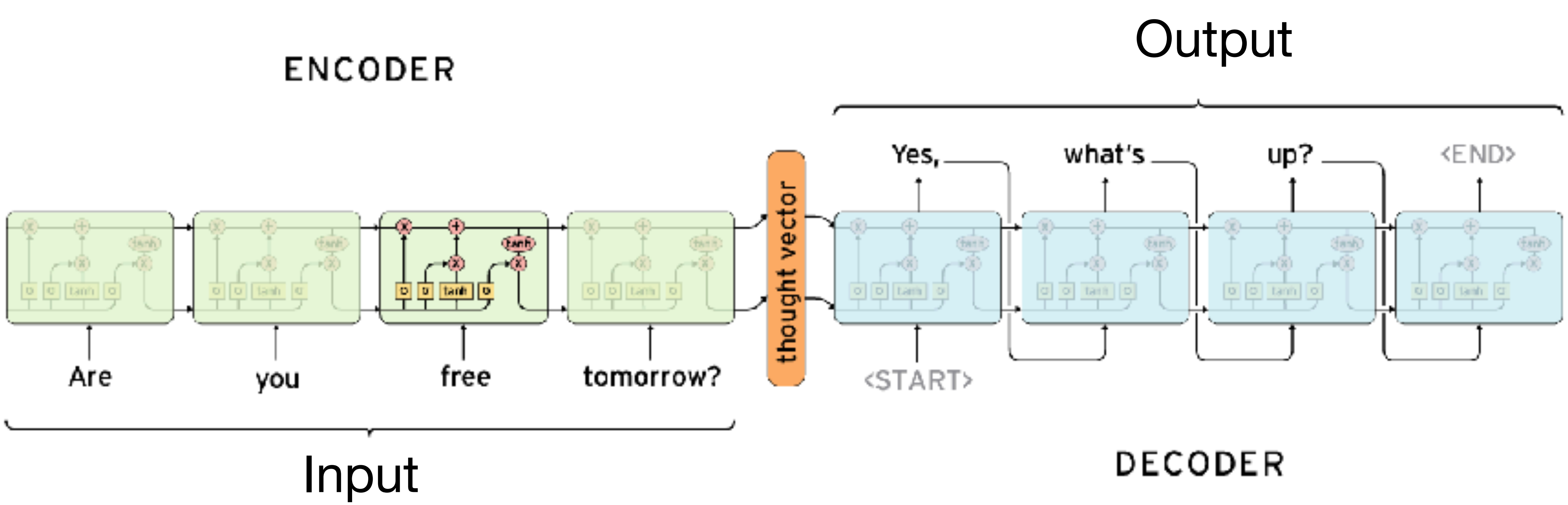
OUTPUT: *I am good. Thanks for asking.*

INPUT: *You're asking me out. That's so cute. What's your name again?*

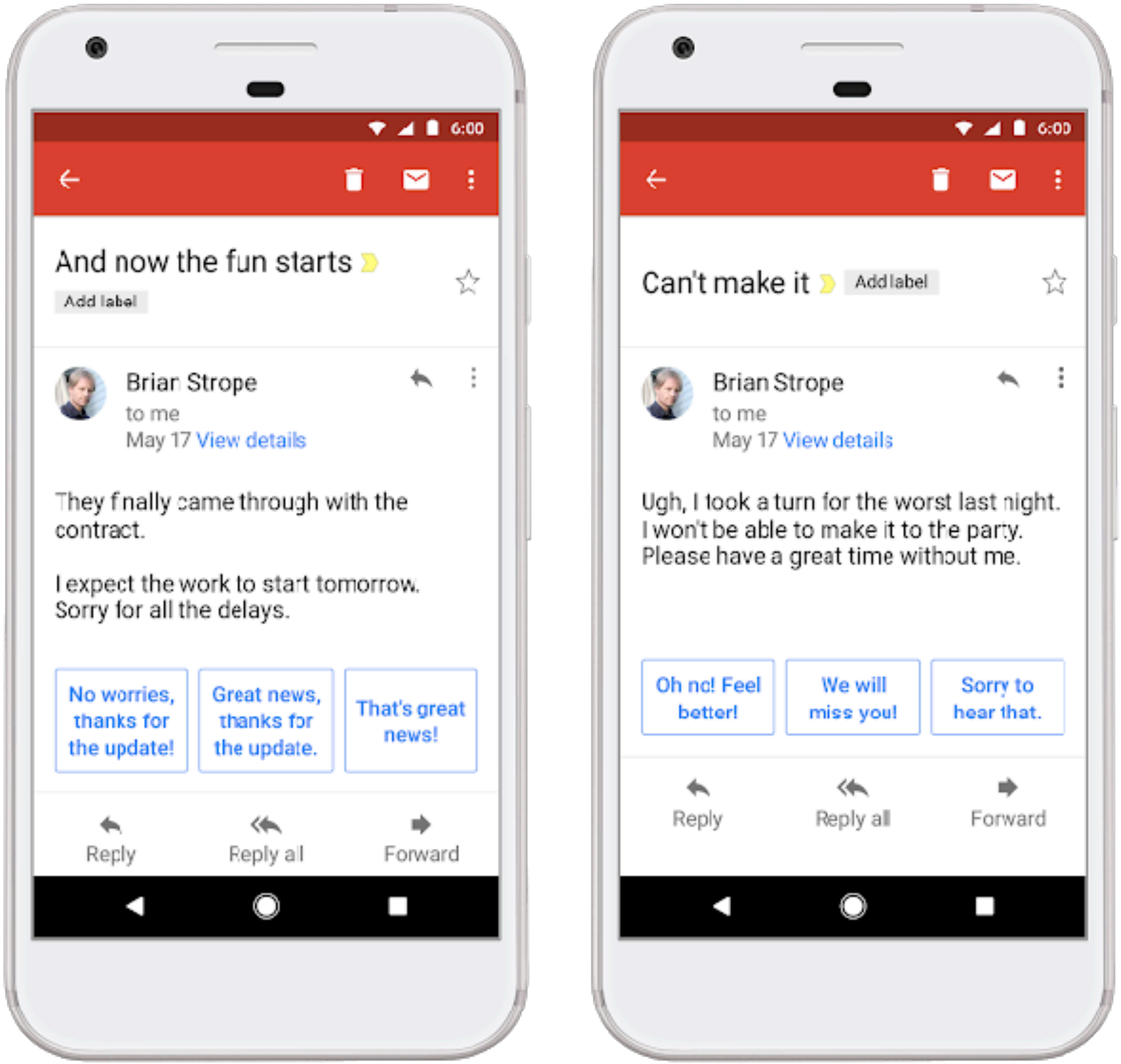
OUTPUT: *Forget it.*

INPUT: *No, no, it's my fault — we didn't have a proper introduction*

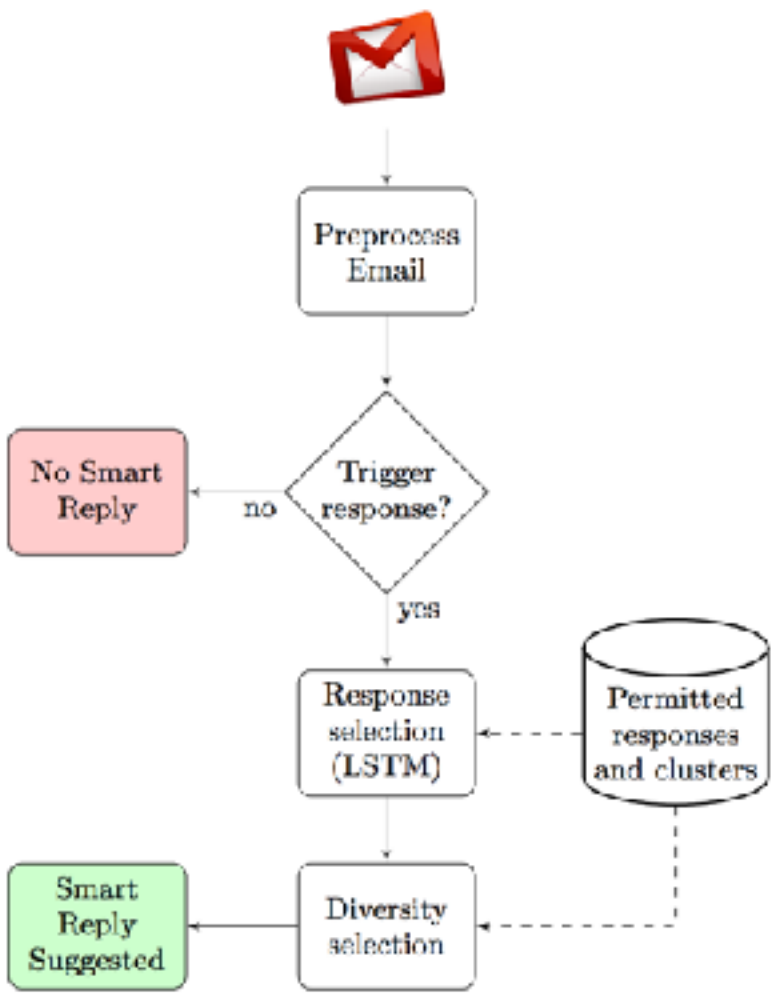
OUTPUT: *Cameron.*



Auto-Reply


6:00
And now the fun starts
Add label
Brian Strope
to me
May 17 View details
They finally came through with the contract.
I expect the work to start tomorrow. Sorry for all the delays.
No worries, thanks for the update!
Great news, thanks for the update.
That's great news!
Reply
Reply all
Forward
6:00
Can't make it
Add label
Brian Strope
to me
May 17 View details
Ugh, I took a turn for the worst last night. I won't be able to make it to the party. Please have a great time without me.
Oh no! Feel better!
We will miss you!
Sorry to hear that.
Reply
Reply all
Forward

Auto-Reply



Query	Top generated responses
Hi, I thought it would be great for us to sit down and chat. I am free Tuesday and Wenesday. Can you do either of those days? Thanks! –Alice	I can do Tuesday. I can do Wednesday. How about Tuesday? I can do Tuesday! I can do Tuesday. What time works for you? I can do Wednesday! I can do Tuesday or Wednesday. How about Wednesday? I can do Wednesday. What time works for you? I can do either.

Kannan et al., Smart Reply: Automated Response Suggestion for Email, SIGKDD 2016

Summary

- RNNs/LSTMs are powerful tools
- Diverse applications
- What NEW problems will you solve?

Online References

- https://distill.pub/2017/ctc/

References

- Graves et al., Connectionist temporal classification: labelling unsegmented sequence data with recurrent neural networks, ICML 06

Thank You

Questions?