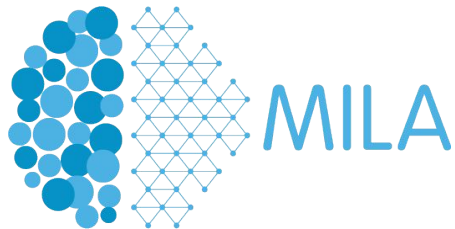


Generative Deep Neural Networks for Dialogue: A Short Review

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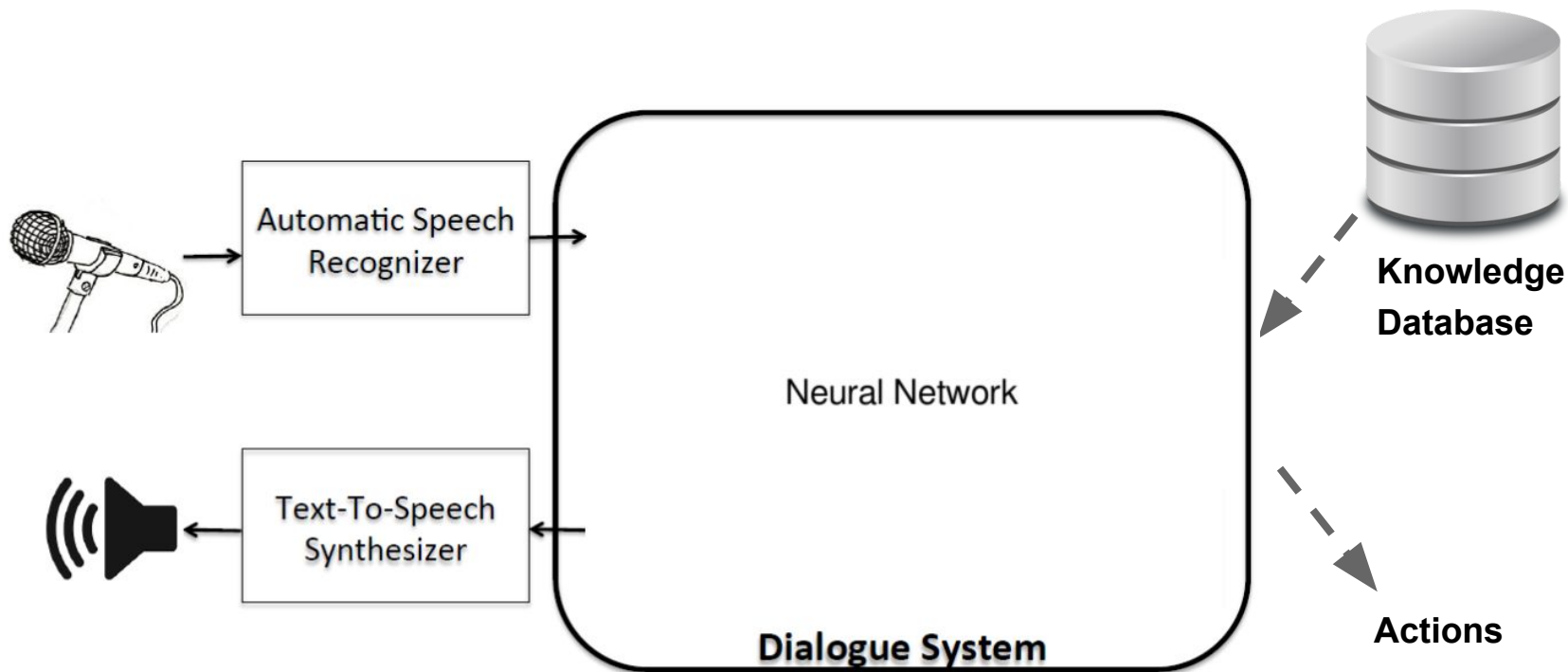
Kartik Talamadupula



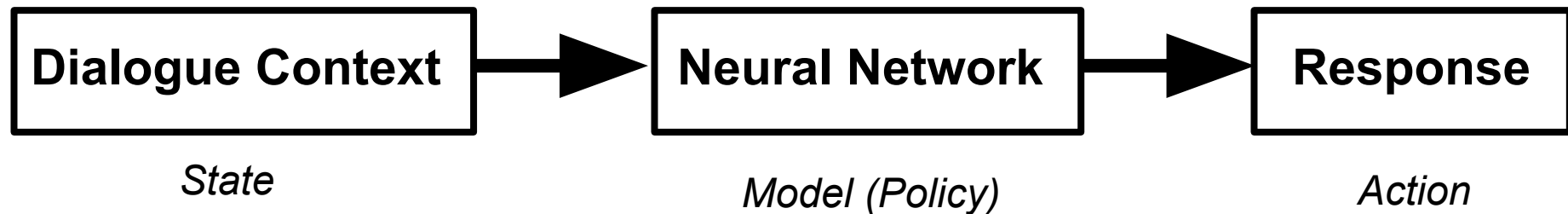
Bowen Zhou

Background

Dialogue Modeling



Dialogue Modeling



Dialogue Modeling

Ubuntu Task:

- goal-driven; users resolve technical problems
- ~0.5M dialogues

Example

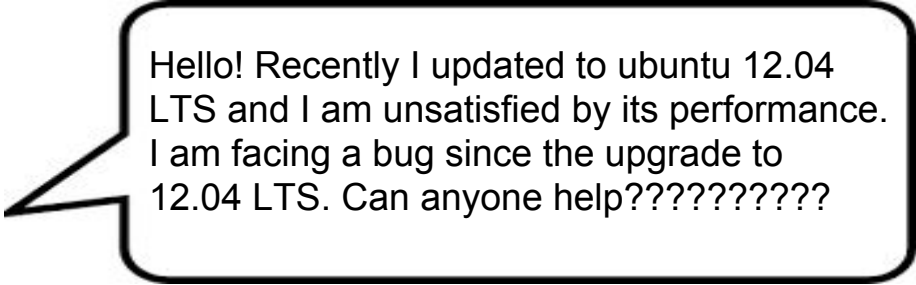
User

Expert



Example

User



Hello! Recently I updated to ubuntu 12.04 LTS and I am unsatisfied by its performance. I am facing a bug since the upgrade to 12.04 LTS. Can anyone help???????????

Expert

Example

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Expert

You need to give more details on the issue.

Example

User

Hello! Recently I updated to ubuntu 12.04 LTS and I am unsatisfied by its performance. I am facing a bug since the upgrade to 12.04 LTS. Can anyone help???????????

Every time I login it gives me "System Error" pop up. It is happening since I upgraded to 12.04.

Expert

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You need to give more details on the issue.

Send a report, or cancel it.

Example

User

Hello! Recently I updated to ubuntu 12.04 LTS and I am unsatisfied by its performance. I am facing a bug since the upgrade to 12.04 LTS. Can anyone help??????????

Every time I login it gives me "System Error" pop up. It is happening since I upgraded to 12.04.

I have already done that but after few min, it pops up again...

Expert

You need to give more details on the issue.

Send a report, or cancel it.

Dialogue Modeling

How can we learn the model?

- Unsupervised Learning (Generative Models)
 - Maximize likelihood w.r.t. words
- Supervised Learning:
 - Maximize likelihood w.r.t. annotated labels
- Reinforcement Learning
 - Learning from real users, learning from simulated users, learning with given reward function

Generative Dialogue Modeling

Conditional response model:

$$P_{\theta}(U_m | U_{<m}) = \prod_{n=1}^{N_m} P_{\theta}(w_{m,n} | w_{m,<n}, U_{<m}),$$

Agent policy as the conditional model:

$$\pi_{\theta}(\text{action} \mid \text{state}) = P_{\theta}(U_m | U_{<m})$$

Possible to condition on other information, such as knowledge bases and user profiles

Generative Dialogue Modeling

Maximizing likelihood on fixed corpora

- Imitating human dialogues:

$$\max_{\theta} \log P_{\theta}(U_1, \dots, U_M) = \max_{\theta} \sum_{m=1}^M \log P_{\theta}(U_m | U_{<m})$$

Generative Dialogue Modeling

Advantages:

1. Learning from massive unlabelled datasets
2. End-to-end trainable (when model is differentiable)
3. Robust, low-variance learning signal
=> powerful framework for Deep Learning models

Generative Dialogue Modeling

Disadvantages:

1. Likelihood optimizes compression (not task goal)
2. Imitating sub-optimal agents (humans)
3. Learning off-policy

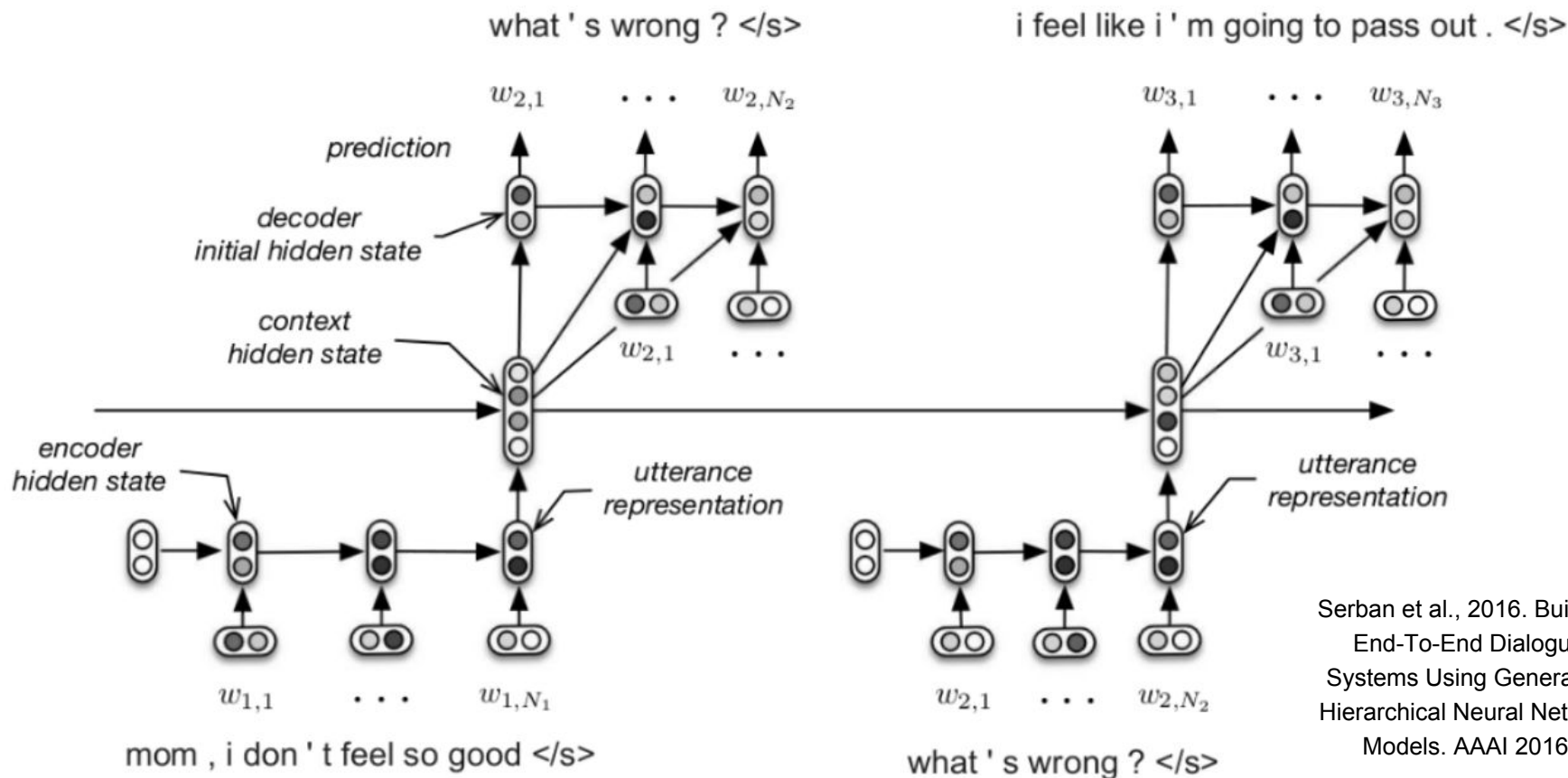
Generative Models

Generative Models

We propose models with three inductive biases:

1. Long-term memory
2. High-level compositional structure
3. Representing uncertainty and ambiguity

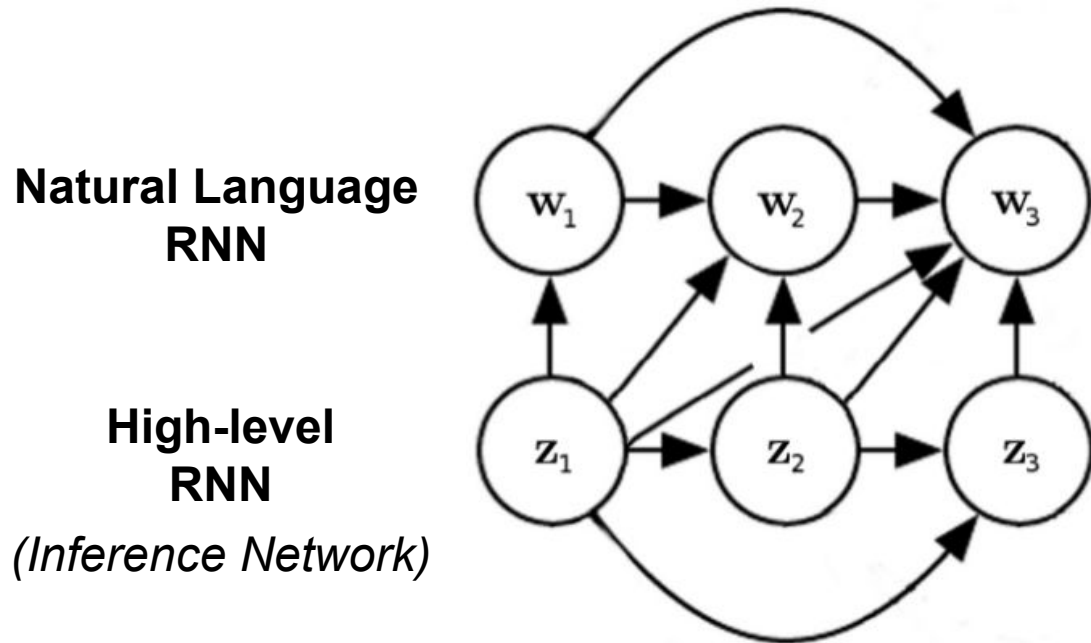
Hierarchical Recurrent Encoder-Decoder (HRED)



Serban et al., 2016. Building End-To-End Dialogue Systems Using Generative Hierarchical Neural Network Models. AAAI 2016.

Multiresolution Recurrent Neural Network (MrRNN)

Modeling compositional structure in two-level RNN:



Serban et al., 2016. Multiresolution Recurrent Neural Networks: An Application to Dialogue Response Generation. AAAI 2017. (In Press)

Multiresolution Recurrent Neural Network (MrRNN)

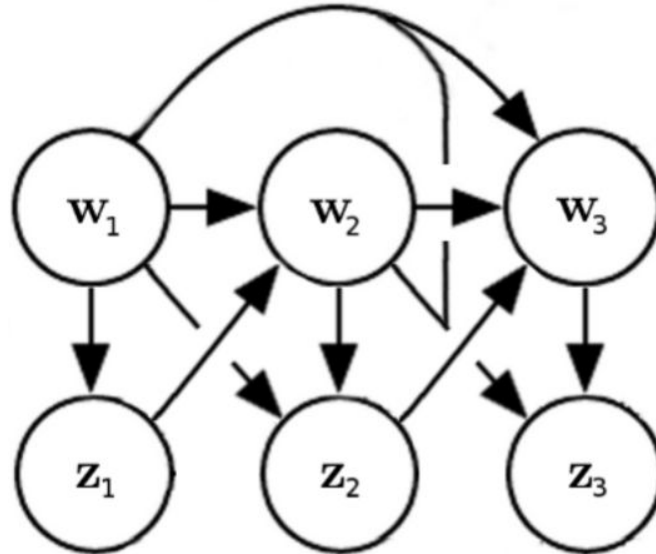
Activity-Entity Representation

- Actions
 - install, update, download, reboot..
- Entities
 - programs, websites commands...

Utterances	Activities-Entities
hello, how can i copy a file from a remote host	present_future_tenses copy_activity host_entity no_cmd
↓	↓
if you have ssh access you can use scp or sftp	present_future_tenses use_activity ssh_entity scp_entity lftp_entity no_cmd
↓	↓

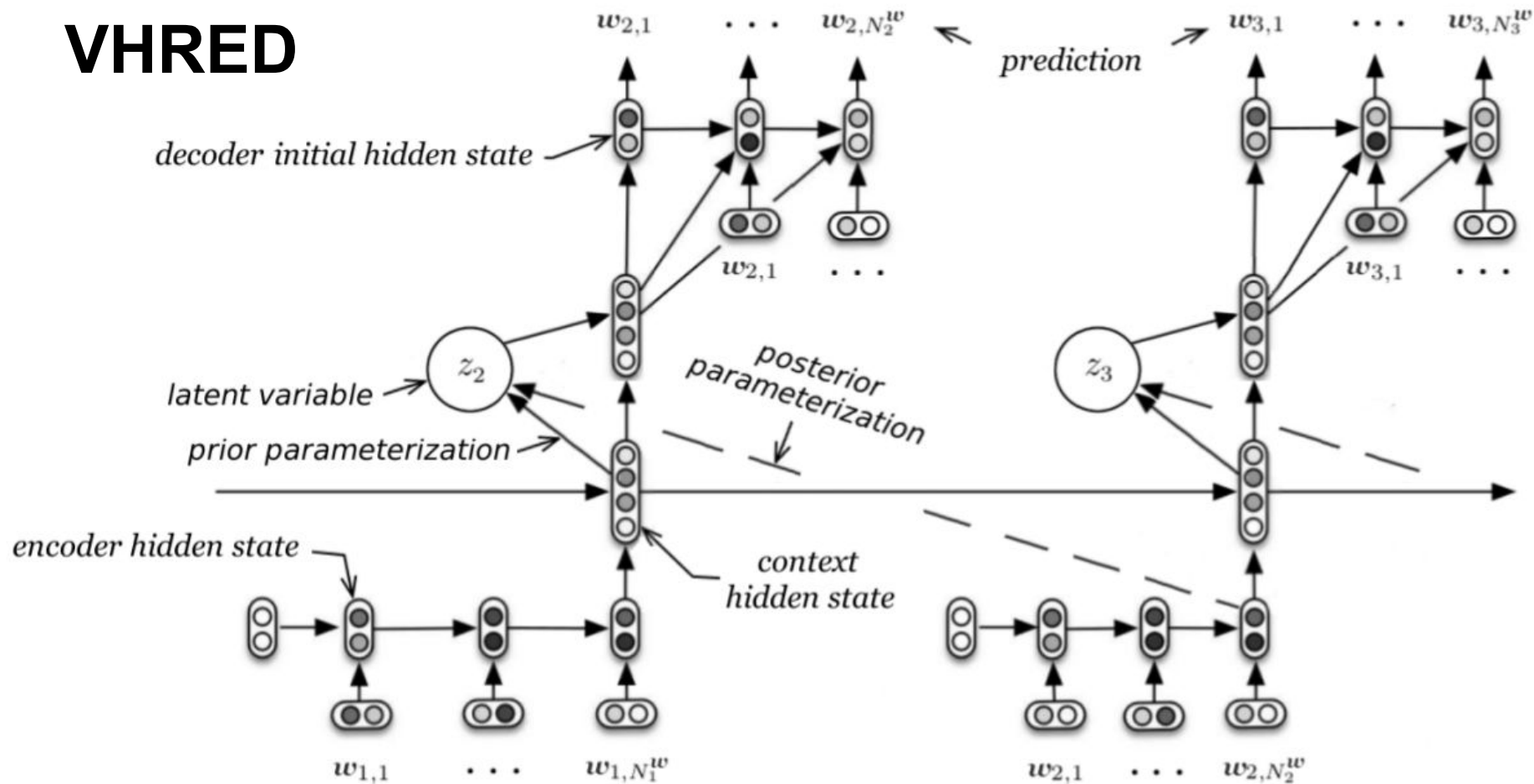
Latent Variable Recurrent Encoder-Decoder (VHRED)

Modeling uncertainty and ambiguity with latent variables:

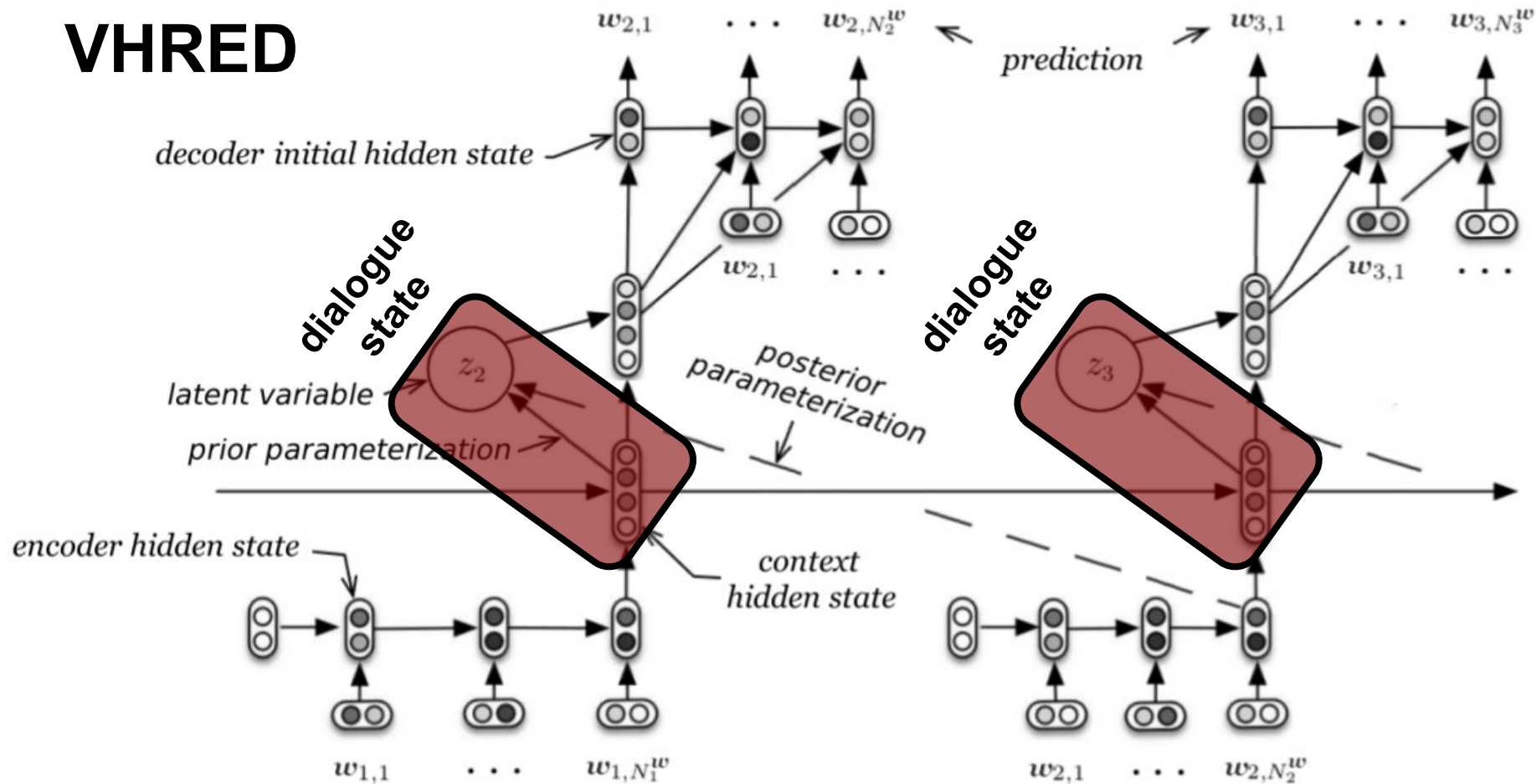


Serban et al., 2016. A Hierarchical Latent Variable Encoder-Decoder Model for Generating Dialogues. AAAI 2017. (In Press)

VHRED



VHRED



Experiments

Experiments

	Activity	Entity
Model	F1	F1
LSTM	1.18 \pm 0.18	0.87 \pm 0.15

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VHRED	4.63 ± 0.34	2.53 ± 0.26

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MrRNN Noun	4.04 \pm 0.33	6.31 \pm0.42
MrRNN Act.-Ent.	11.43 \pm0.54	3.72 \pm 0.33

Experiments

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HRED	4.34 \pm 0.34	2.22 \pm 0.25
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HRED + Act.-Ent.	5.46 \pm 0.35	2.44 \pm 0.26
MrRNN Noun	4.04 \pm 0.33	6.31 \pm0.42
MrRNN Act.-Ent.	11.43 \pm0.54	3.72 \pm 0.33

Experiments

	Activity	Entity	Human Eval.	
Model	F1	F1	F	R
LSTM	1.18 \pm 0.18	0.87 \pm 0.15	-	-
HRED	4.34 \pm 0.34	2.22 \pm 0.25	2.98	1.01
VHRED	4.63 \pm 0.34	2.53 \pm 0.26	-	-
HRED + Act.-Ent.	5.46 \pm 0.35	2.44 \pm 0.26	2.96	0.75
MrRNN Noun	4.04 \pm 0.33	6.31 \pm0.42	3.48*	1.32*
MrRNN Act.-Ent.	11.43 \pm0.54	3.72 \pm 0.33	3.42*	1.04

Ubuntu model examples. The arrows indicate change of turn.

Context	Response
Hello I tried to install ubuntu studio but I get W : Failed to fetch <url >404 Not Found when apt-get update → the ppa you added is not online	MrRNN Act. -Ent.: try a different mirror MrRNN Noun: something VHRED: but I dont know how to add it HRED: how do I do that ?
hi community.. is there any difference between " /.bashrc " " /.bashrc. local " → yes, they're different files :-)) the default /.bashrc sources /.bashrc. local → sorry I could undersatnd... If I write on terminal " gedit /.bashrc " it opens a file but how I open " /.bashrc. local " → " gedit /.bashrc. local "... → but it just open blank file nothing inside it	MrRNN Act. -Ent.: open up gedit /.bashrc, there is a file called " something " MrRNN Noun: the file is empty.. VHRED: it's in /.bashrc or /.bashrc HRED: what are you trying to do ?
Hey guys what do you in general use for irc something ubuntu xchat or xchat-gnome ? → without -gnome. that is just cut down → you mean drop xchat-gnome and go with xchat ?	MrRNN Act. -Ent.: im using xchat right now MrRNN Noun: what is xchat-gnome ? VHRED: correct HRED: yes
- when setting up rules with iptables command only writes changes this file " etciptables. rules "? i ask this so i can backup before messing anything → sudo iptables-save something . dat to backup your rules restore with sudo iptables-restore < something . dat	MrRNN Act. -Ent.: I don't see any reason why you need iptables to do that MrRNN Noun: are you using ubuntu ? VHRED: thx HRED: thanks

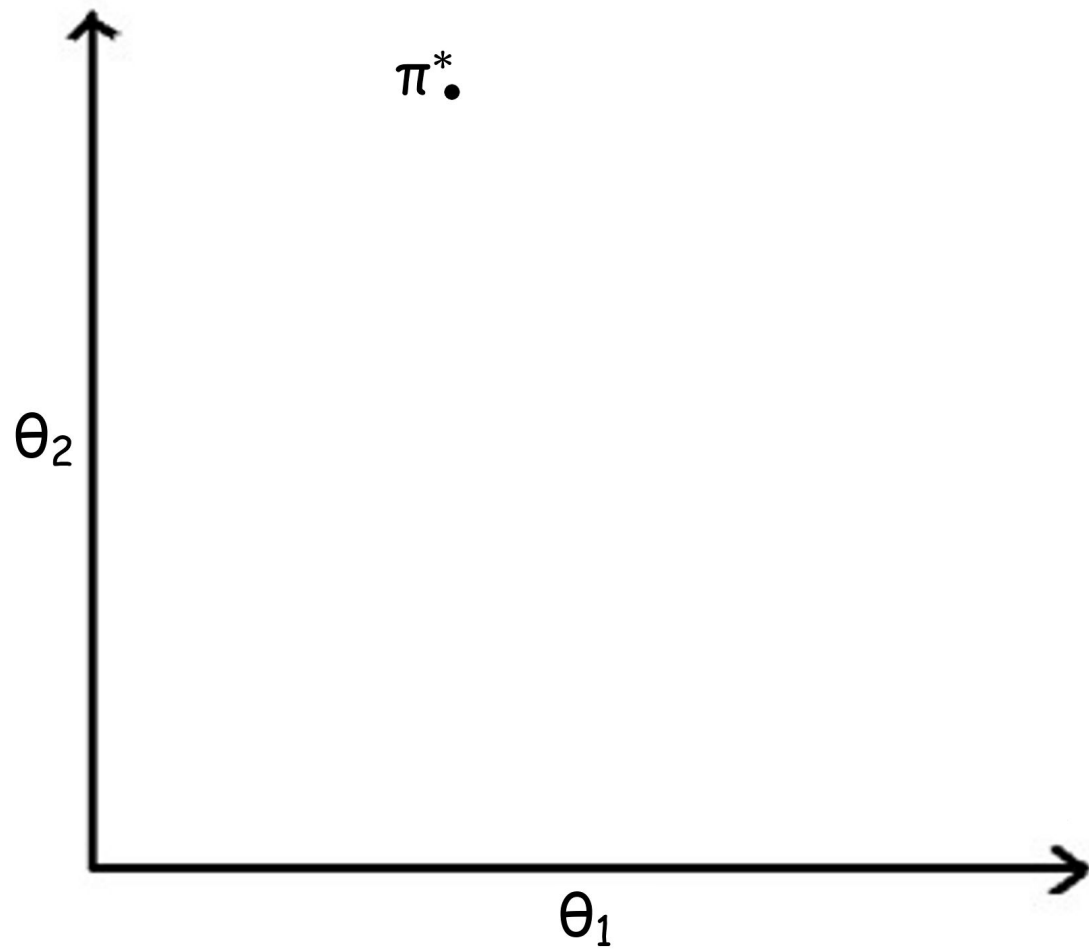
The Big Picture

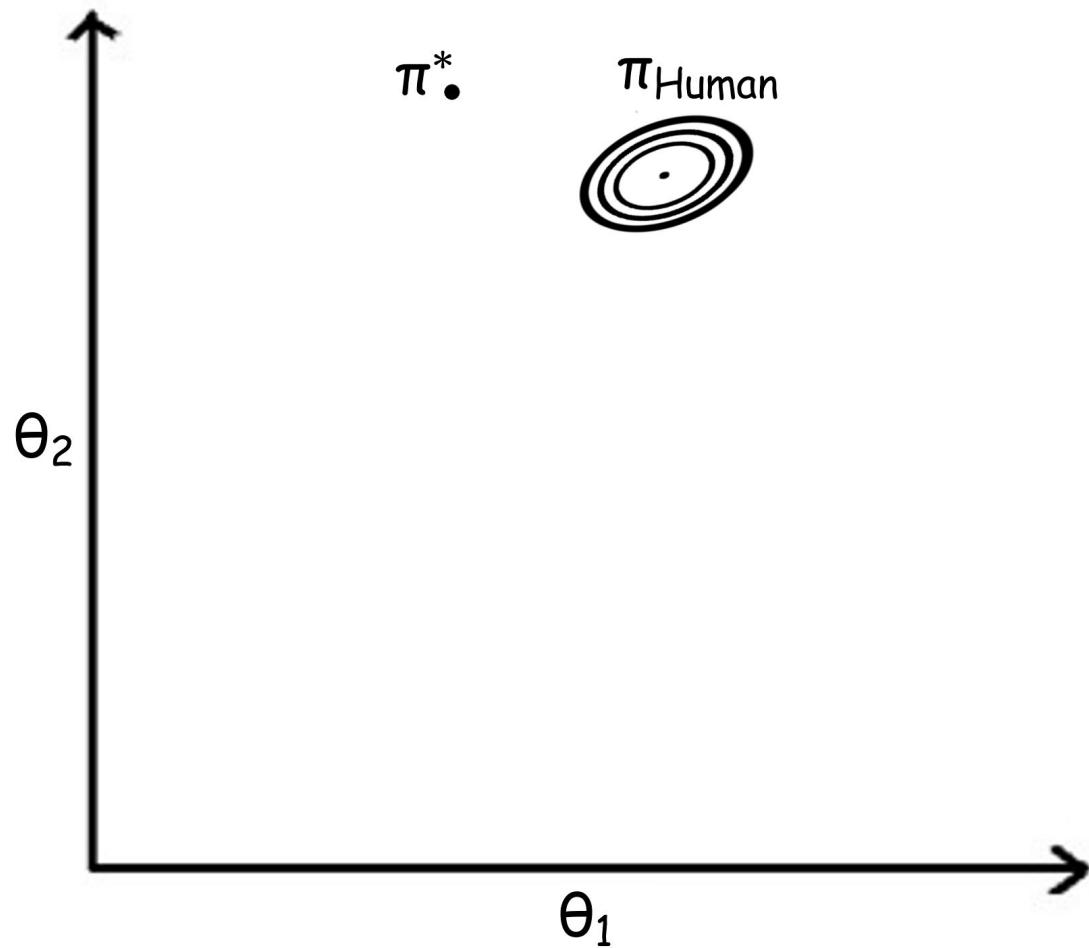
Bias-variance Tradeoff

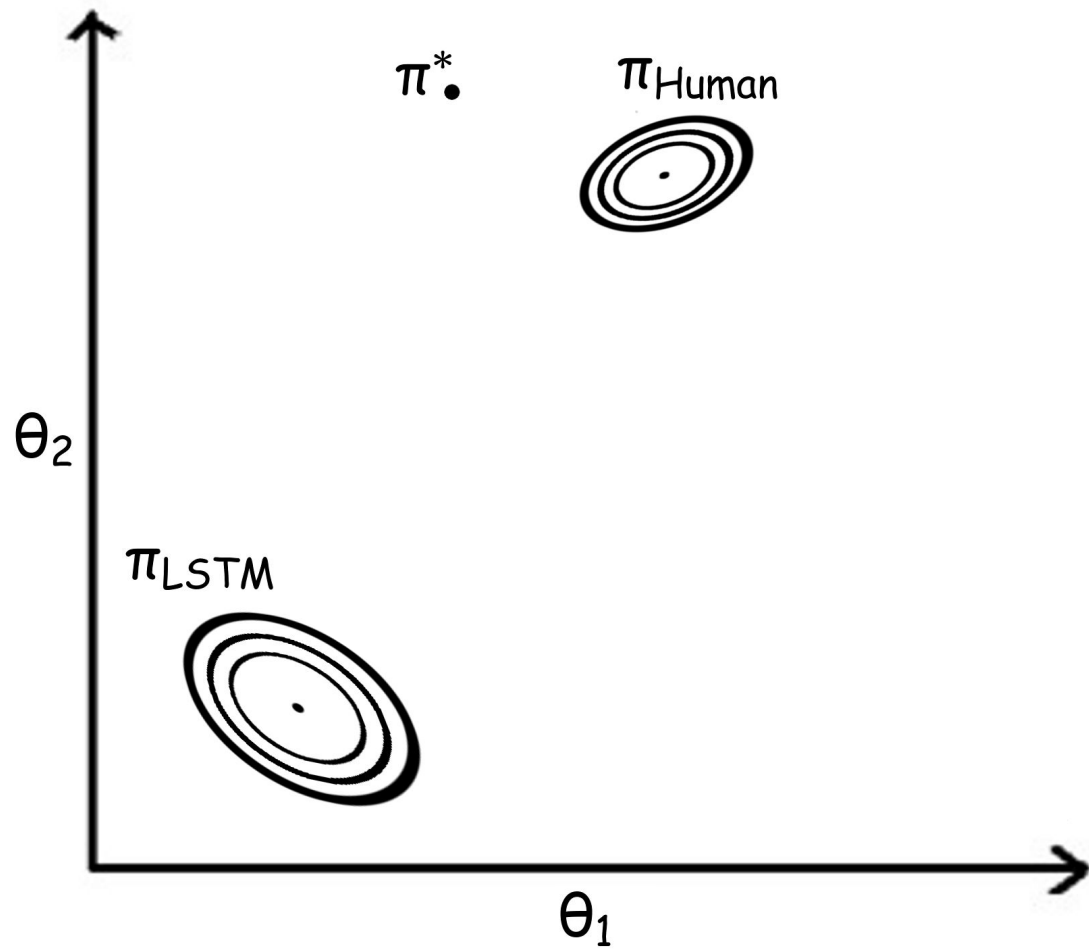
Let π^* be the oracle policy and π be the model policy

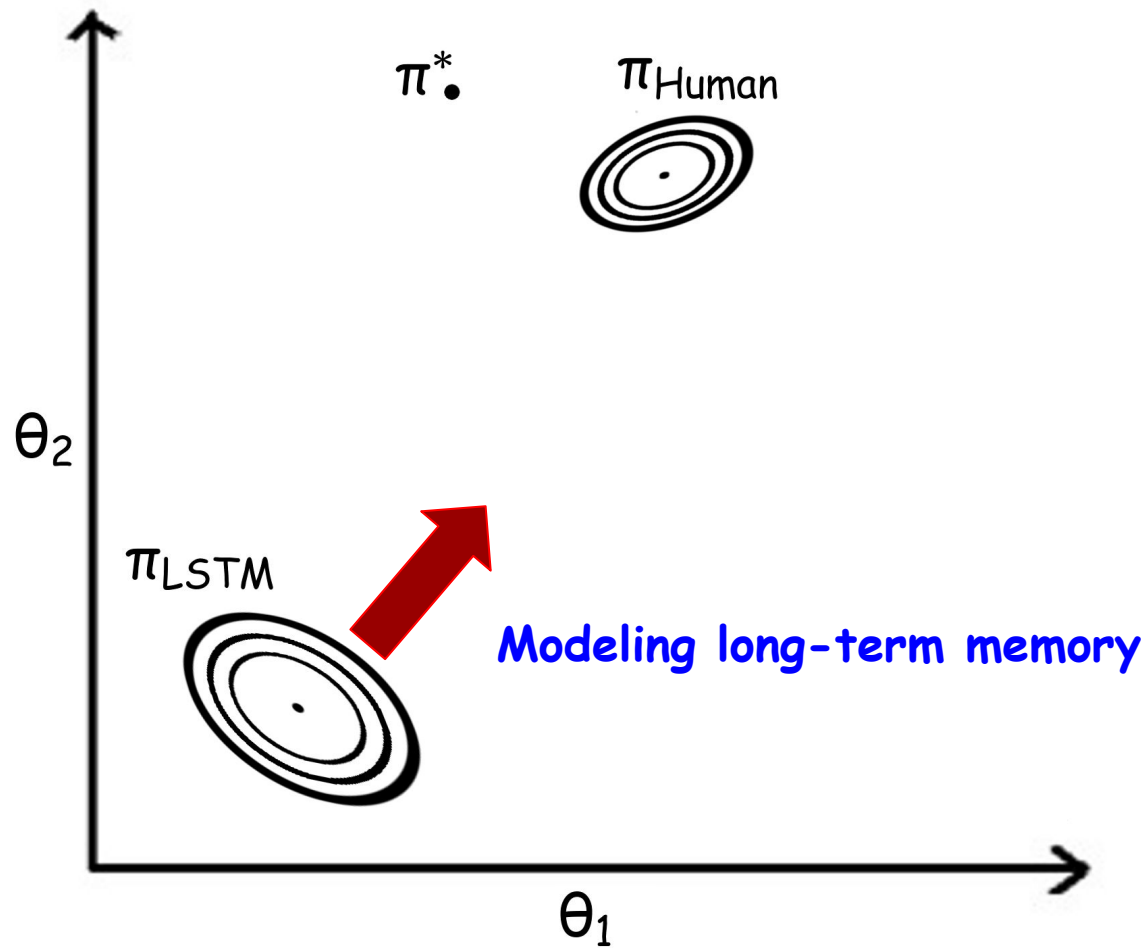
Generalization error w.r.t. training dataset:

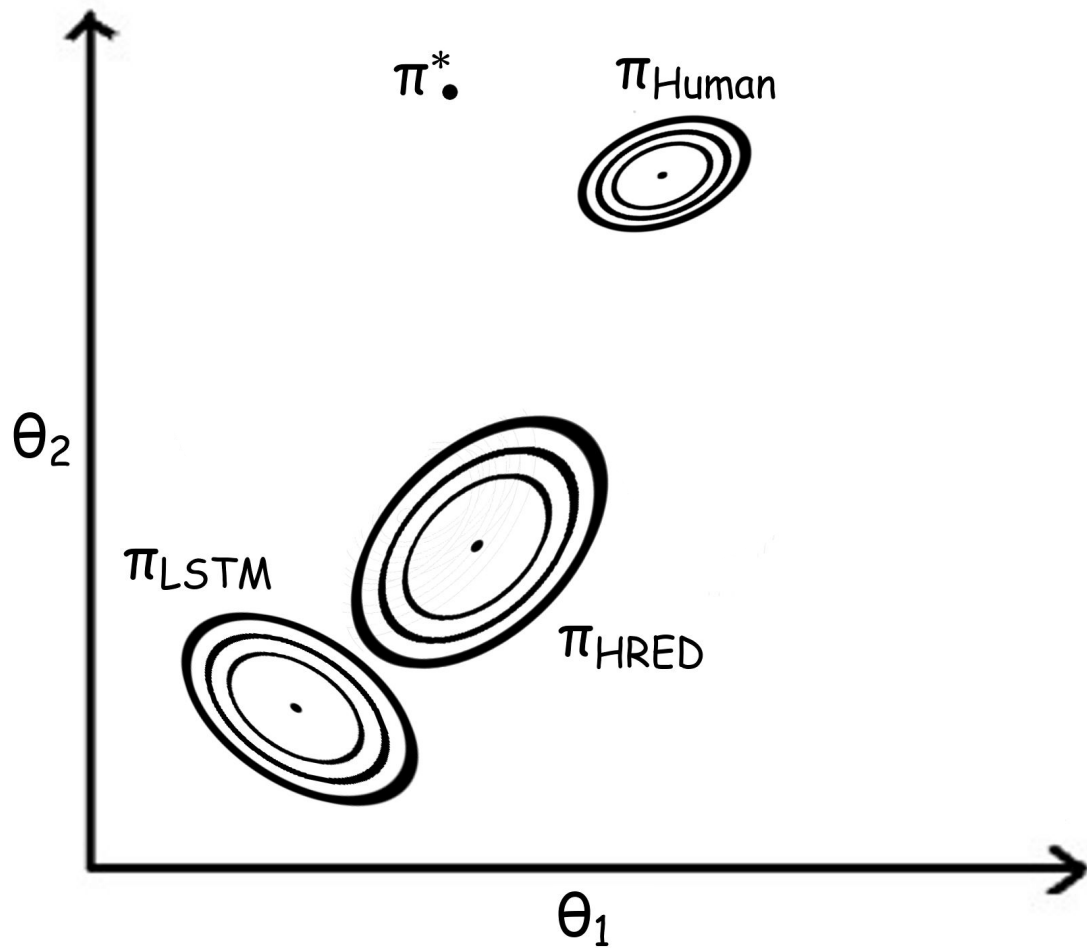
$$\begin{aligned}\text{Error} &= \mathbb{E}_{\text{Train}}[(\pi - \pi^*)^2] \\ &= (\mathbb{E}_{\text{Train}}[\pi] - \pi^*)^2 + \mathbb{E}_{\text{Train}}[(\mathbb{E}_{\text{Train}}[\pi] - \pi)^2] \\ &= \text{Bias}^2 + \text{Variance}\end{aligned}$$

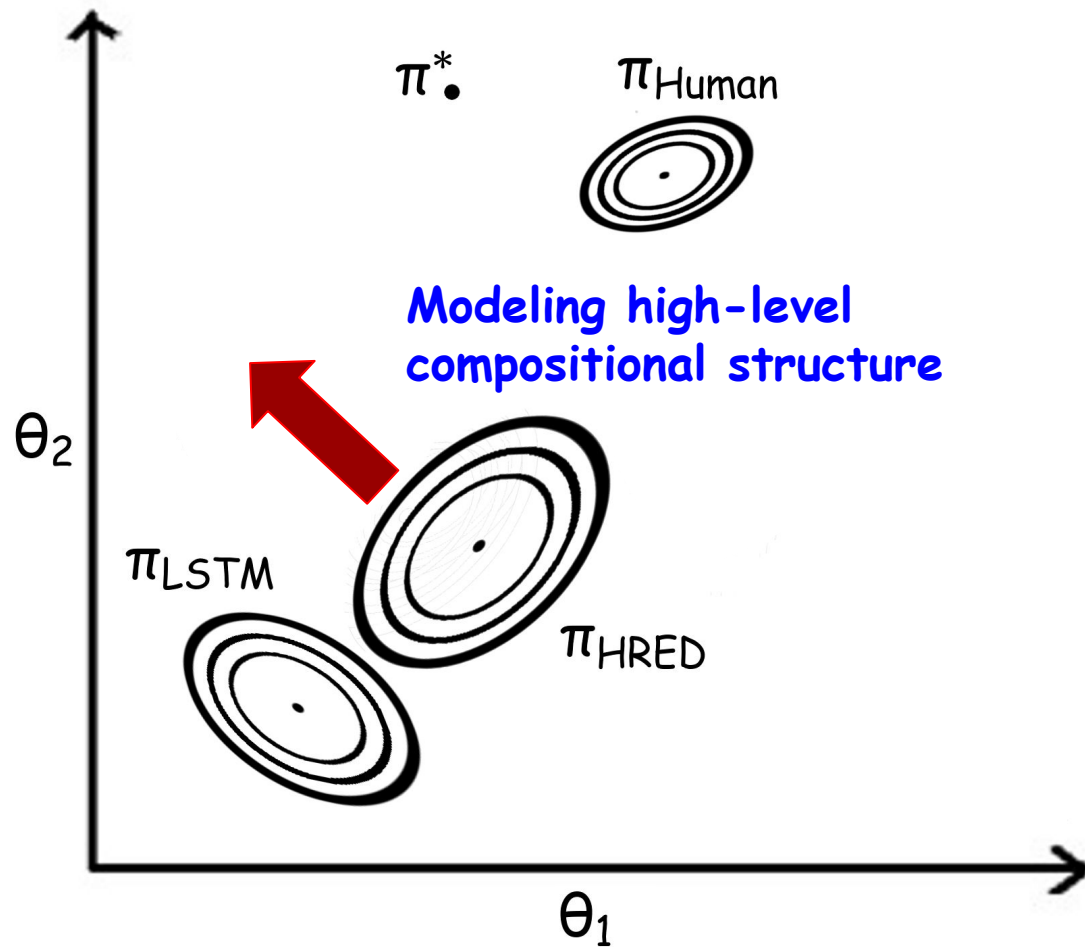


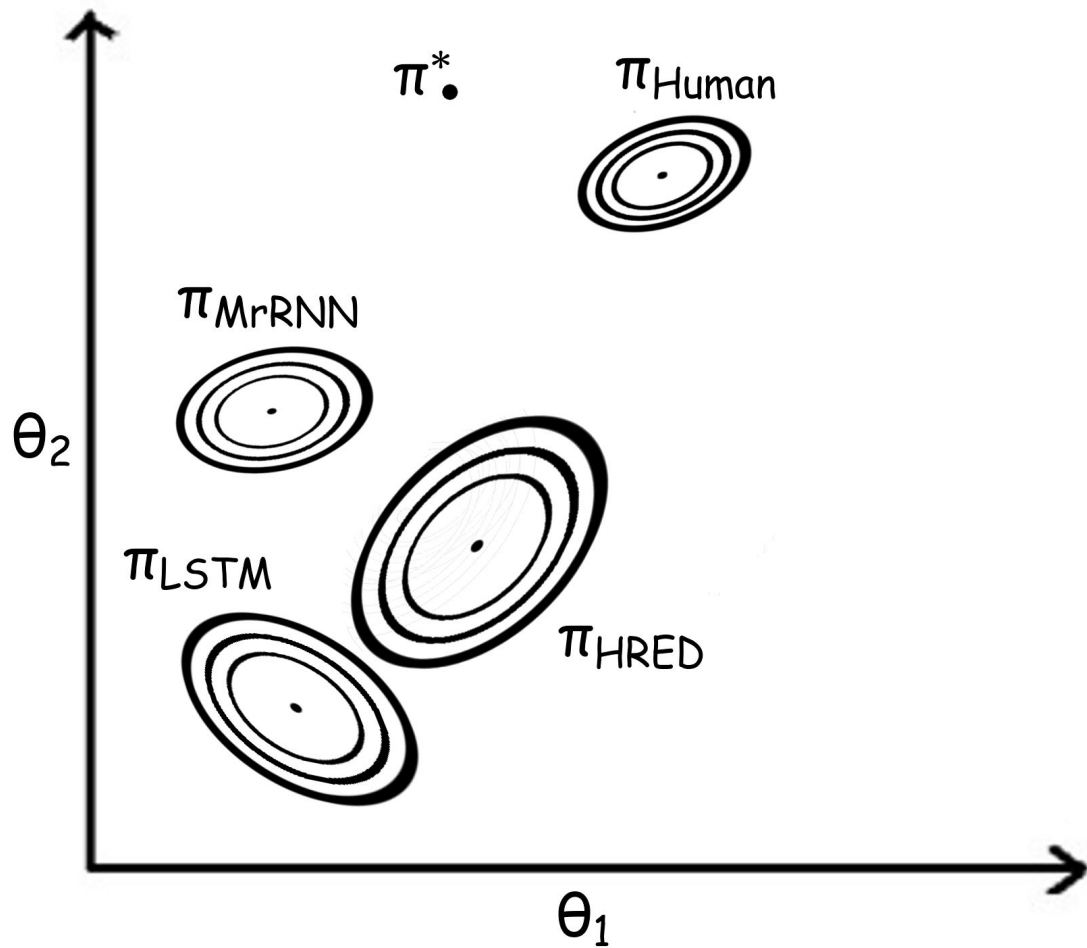


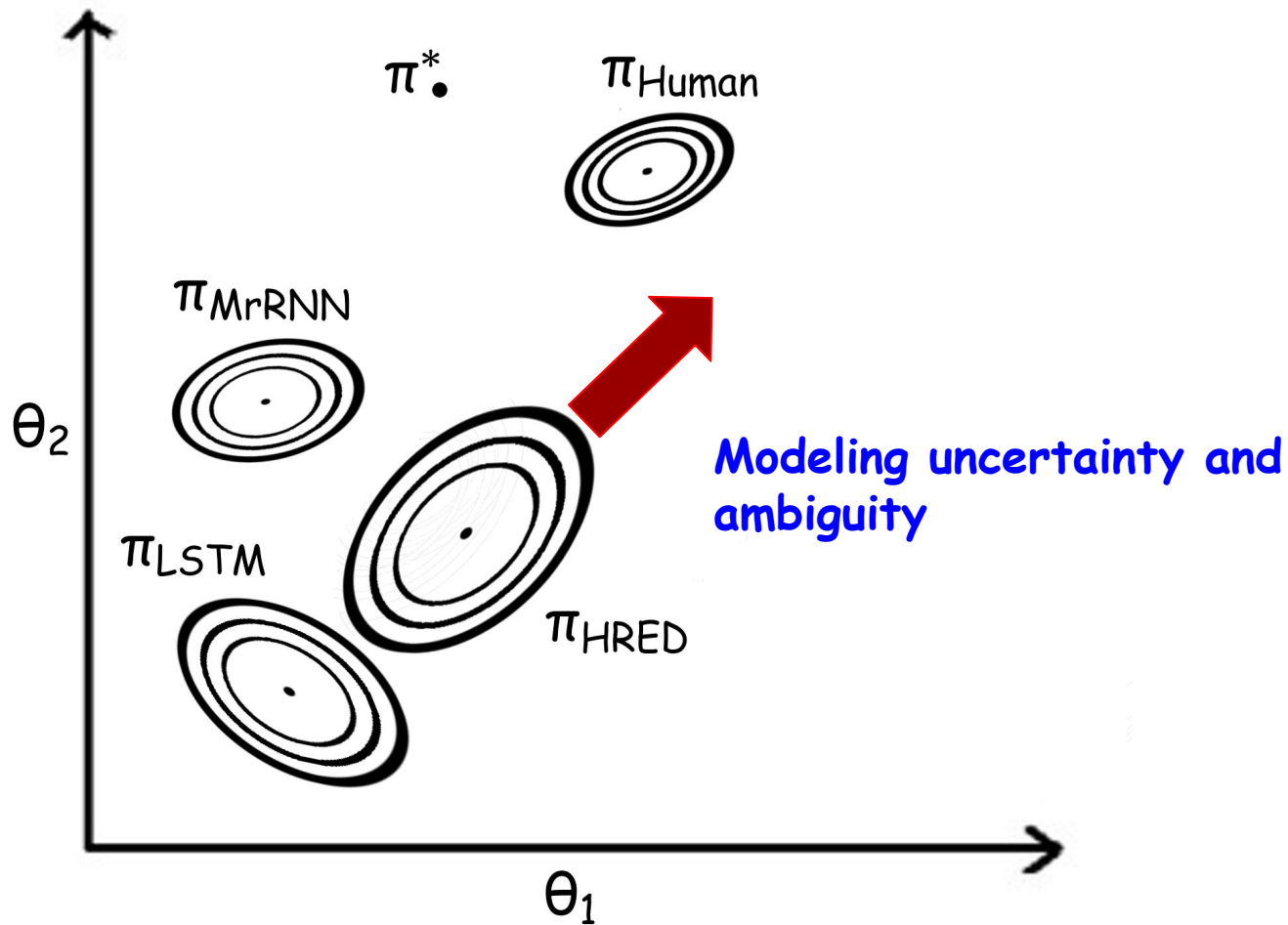


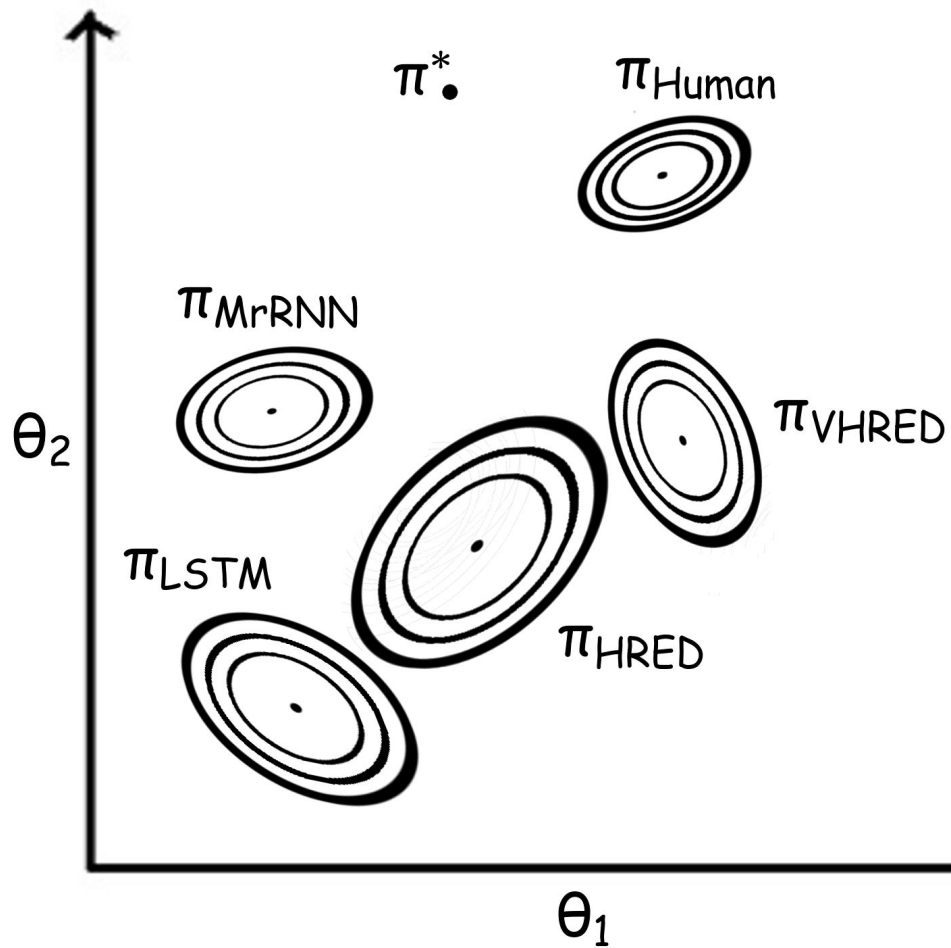












Thank you!

Questions?