

## Project P2: Autonomous Acoustic Systems

# Autonomous Hearing Aids



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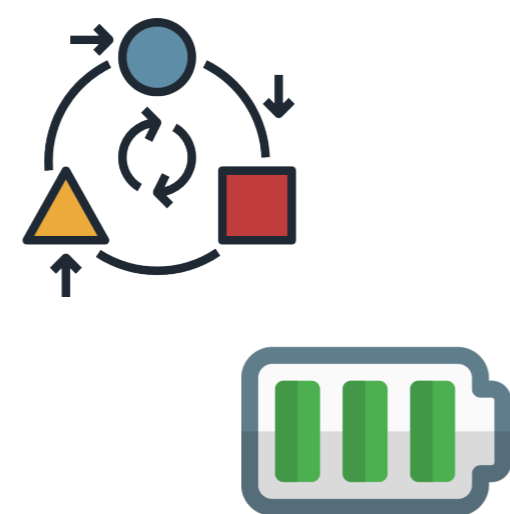


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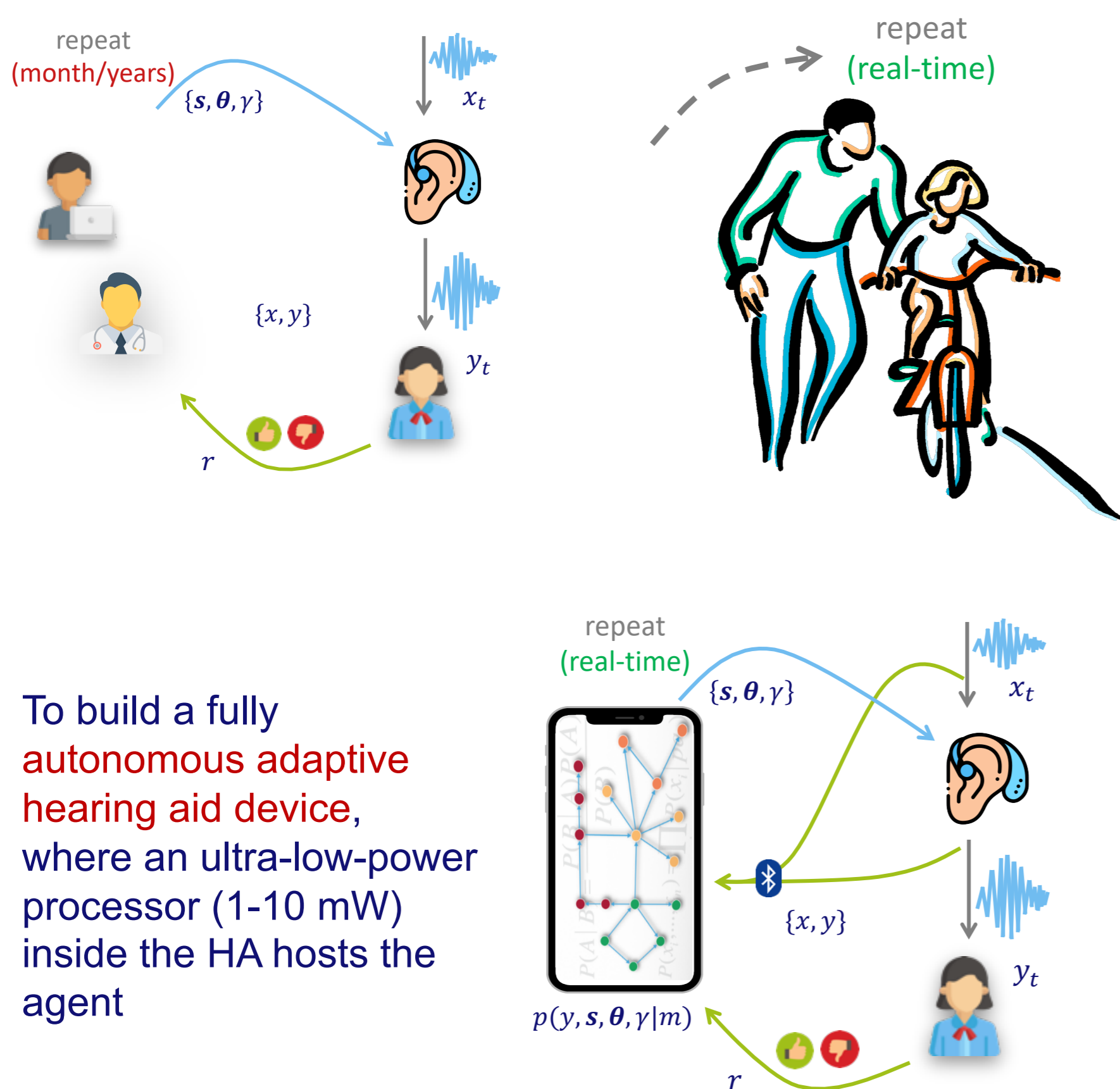
We aim at building an active inference-based agent that designs personalized audio processing algorithms iteratively through real-time, situated interactions with a (human) client. Following the “good regulator” theorem, if an agent is to regulate the state of its environment efficiently (e.g. satisfy a user, enhance speech signal), then it must internalize a model of its environment. In this work we focus on improving speech intelligibility, meaning that we need a model to encode speech. It turns out that hierarchical autoregressive (HAR) models serve good proxies for speech signal which exhibits lots of non-stationarities. Unfortunately, online adaptation in these models remains a challenge. In this work, we propose a hybrid message passing-based method to track states and parameters in HAR-like models.

### Autonomy

- Self-organizing adaptation to changing environmental conditions
- Minimal power consumption

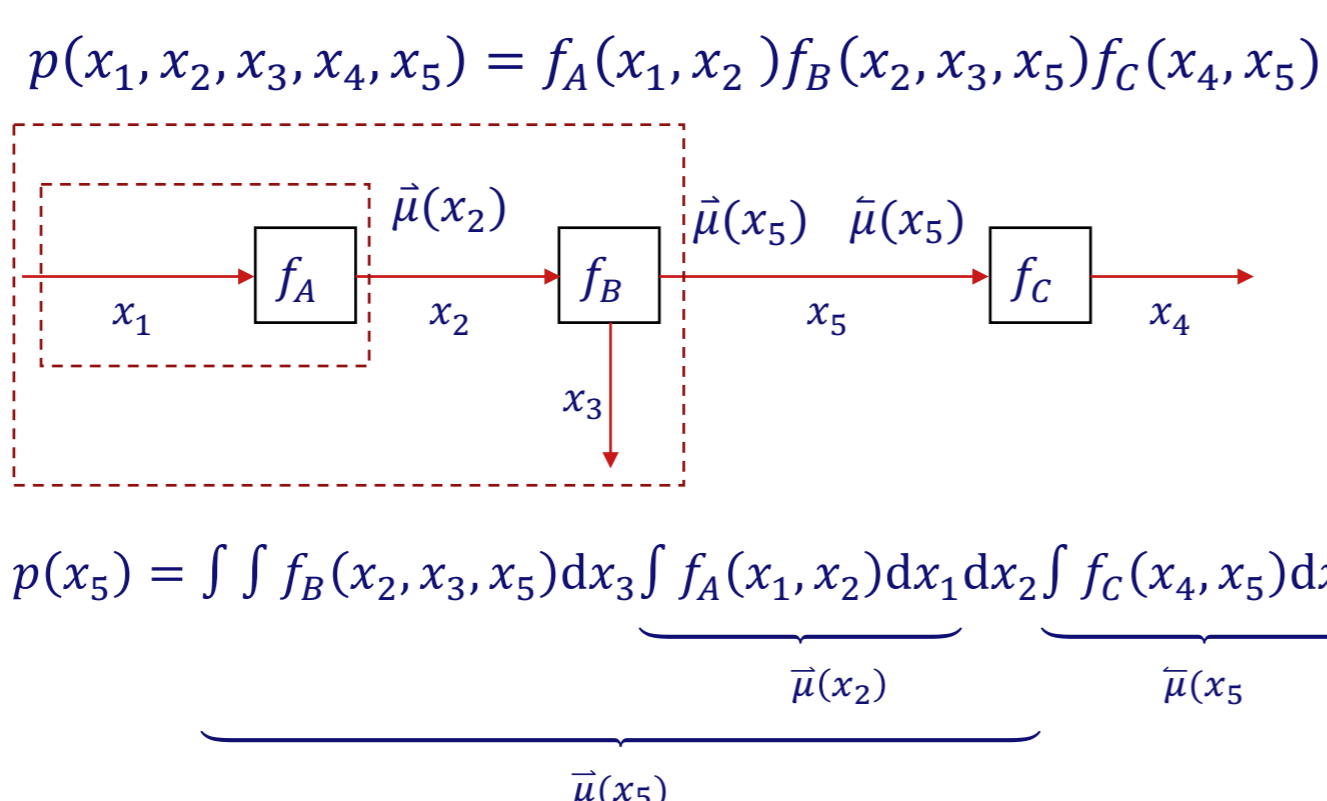


### Goal



### Forney-style Factor Graphs (FFG)

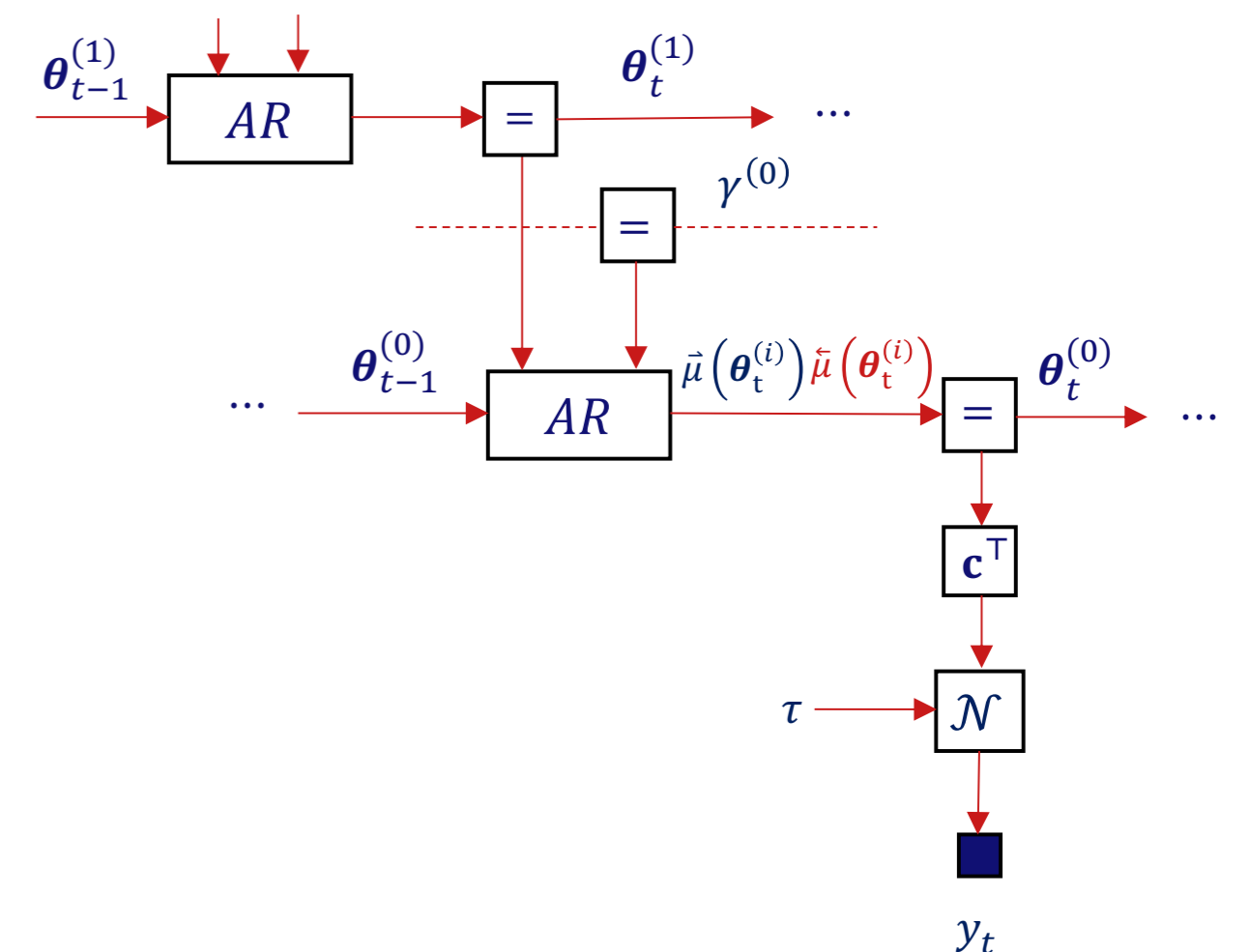
Signal processing and parameter estimation algorithms can be realized by message passing on an FFG:



- Kalman filtering
- Hidden Markov modeling
- Learning of (deep) neural networks.

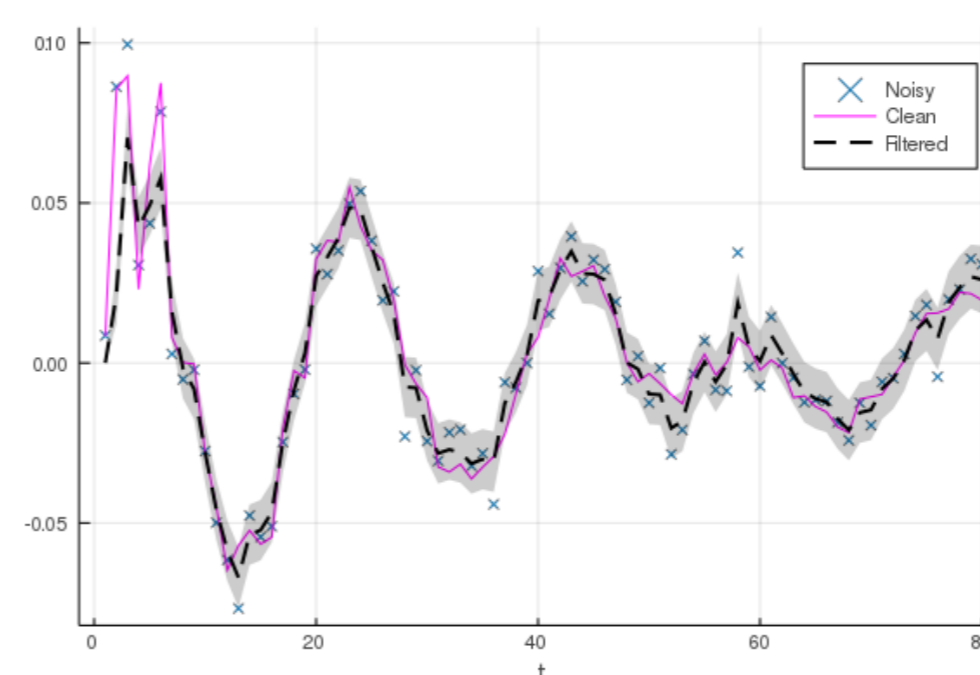
### HAR inference

- Hybrid message-passing (MP) scheme for online inference in hierarchical model
- The proposed message-passing scheme easily extends to other non-stationary dynamic modeling problems.

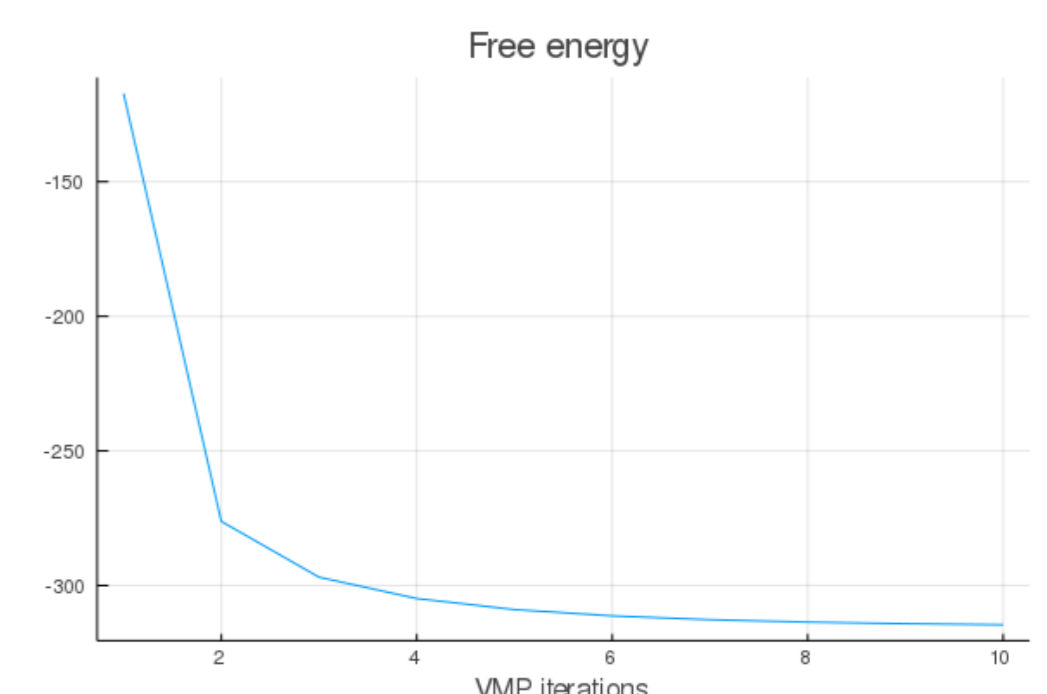


### Experiments

Tracking of hidden states:



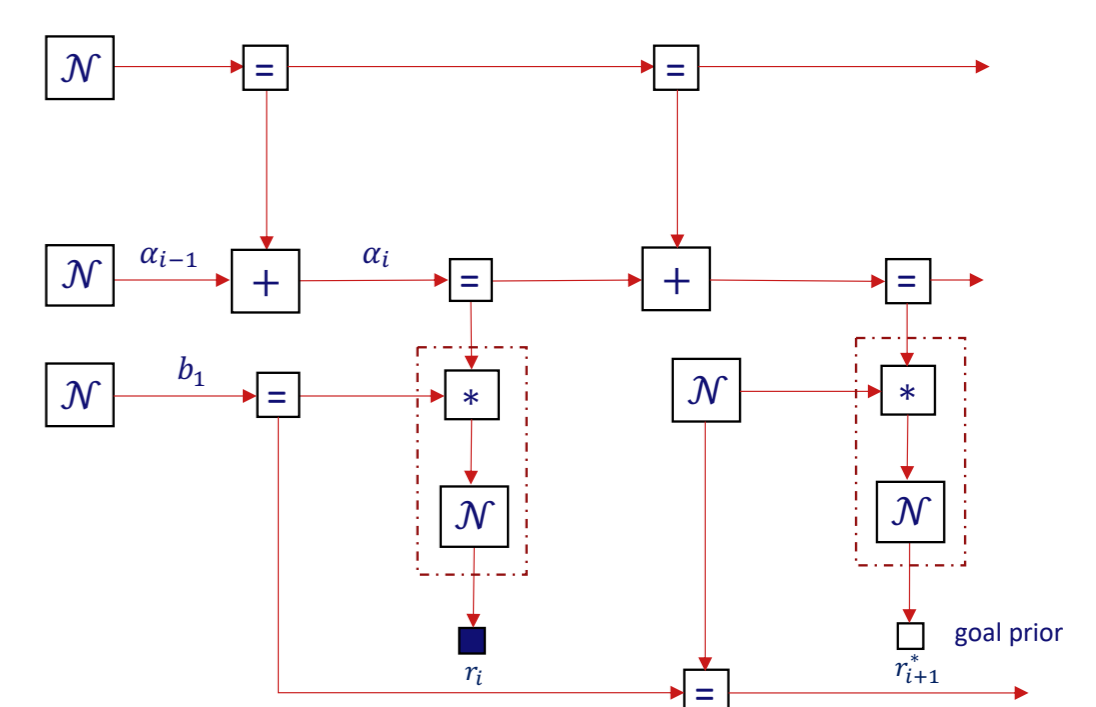
Online scoring:



### Ongoing work

Message Passing for:

- Model the user responses
- Infer the actions



### Acknowledgements:

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### Published:

- [1] Podusenko, A., Kouw, W. M., & de Vries, A. B. (2020). Online variational message passing in hierarchical autoregressive models. ISIT 2020
- [2] Senoz, I., Podusenko, A., Kouw, W. M., & de Vries, A. B. (2020). Bayesian joint state and parameter tracking in autoregressive models. L4DC 2020

