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Paper QR

Haphazard Inputs: Handling Dimension Varying Inputs in an Online Setting



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Problem Statement

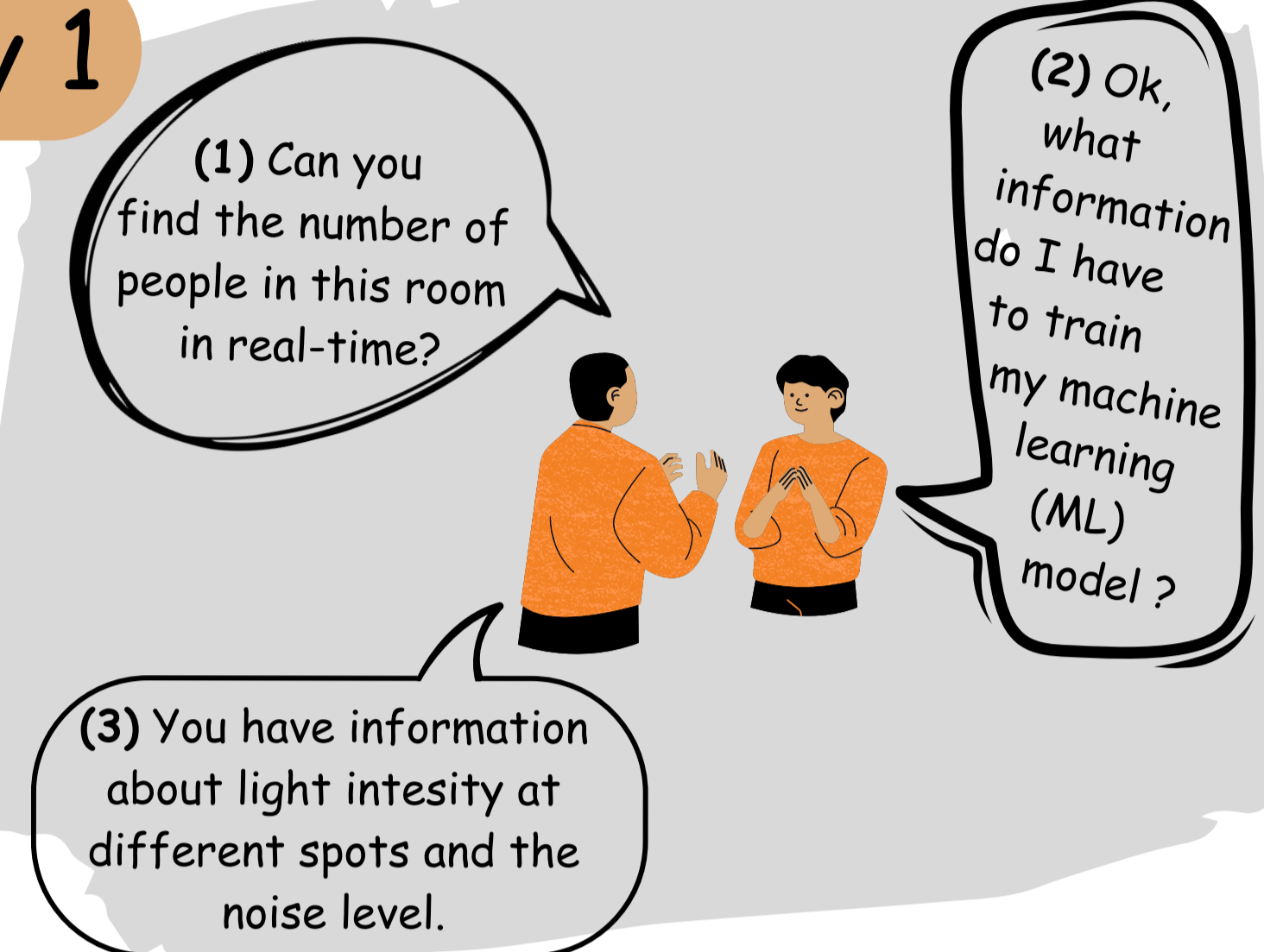
Day 1



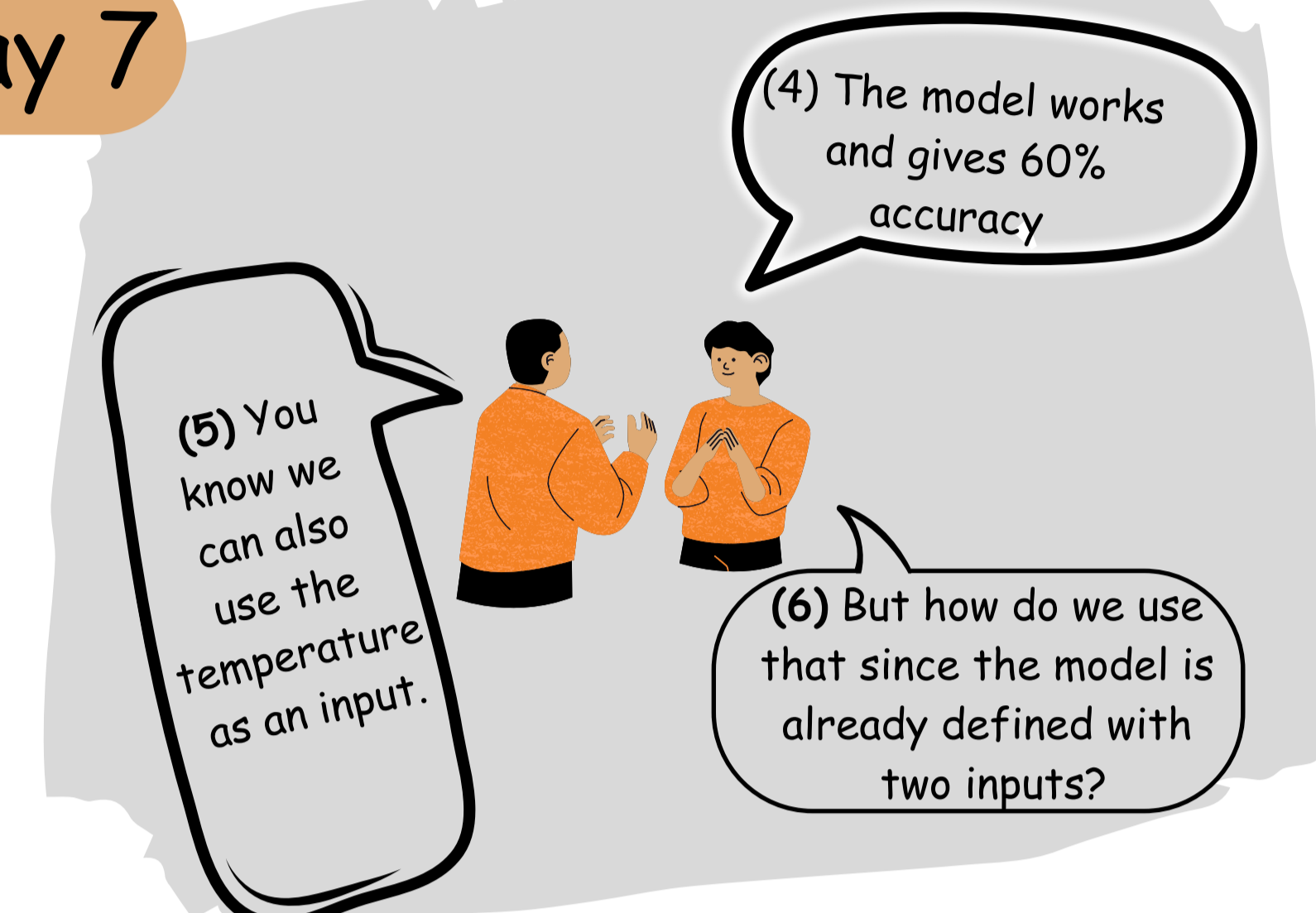
Dilip Rohit

Me and my supervisor attending NORA Annual Conference 2022

Day 1

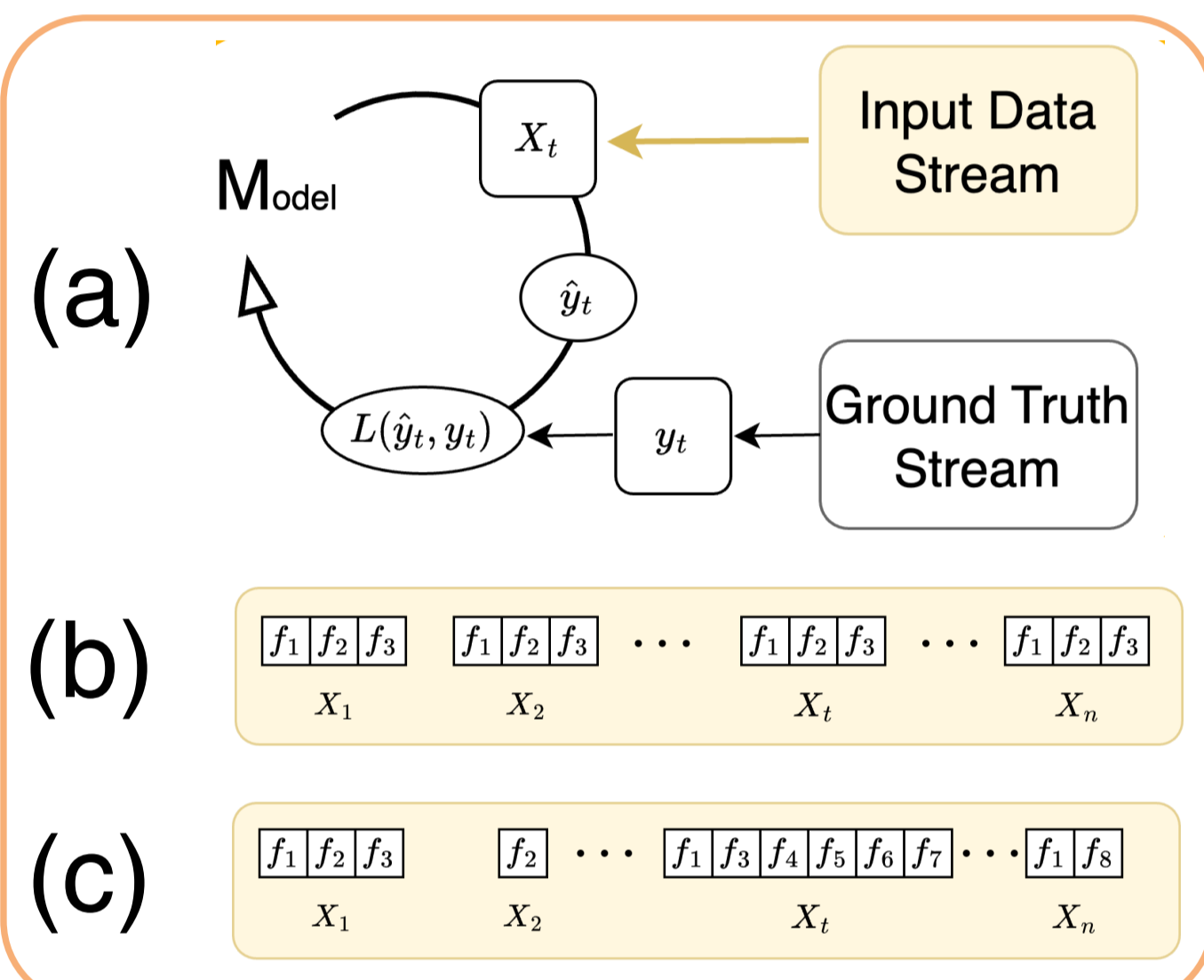


Day 7



Can you help Rohit solve this problem

Haphazard Inputs: Dimension-Varying Inputs



(a) Online Learning, (b) Traditional Online Learning, (c) Haphazard Inputs

Characteristics	Aux-Drop	Online Deep Learning Methods like ODL [1] and OGD [1]	ODL + Online Data Imputation	ODL + Extrapolation
Streaming data	✓	✓	✓	✓
Missing data	✓	×	✓	×
Missing features	✓	×	×	×
Obsolete features	✓	×	×	✓
Sudden features	✓	×	×	×
Unknown no. of features	✓	×	×	×

Comparison of Models with Respect to Handling Haphazard Inputs

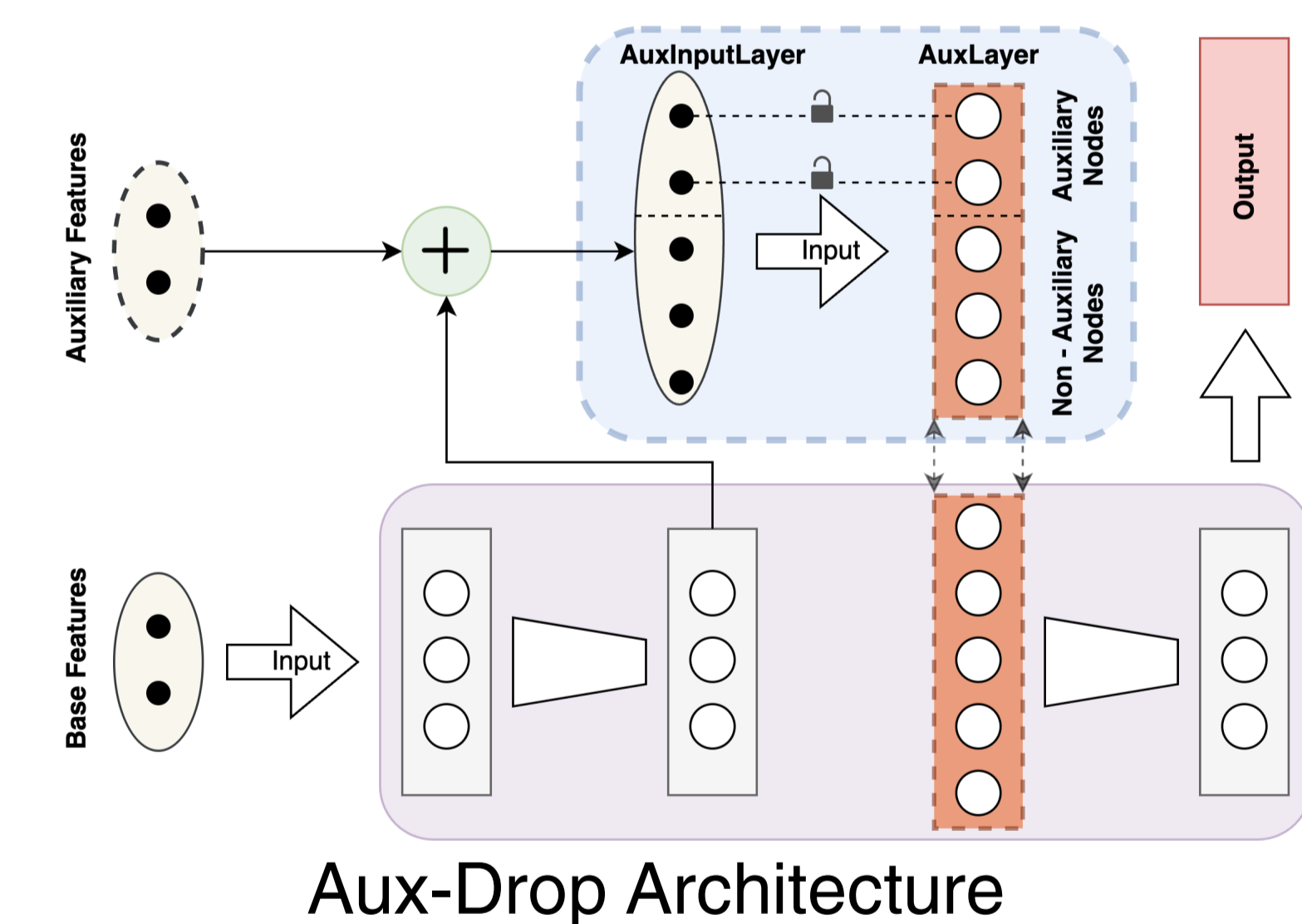
Characteristics	Features	Time Stamps				
		1	2	3	4	5
Streaming Data	F_1	✓	✓	✓	✓	✓
Missing Data	F_2	✓	✓	×	✓	×
Missing Feature	F_3	?	?	✓	✓	✓
Obsolete Feature	F_4	✓	✓	×	×	×
Sudden Feature	F_5	○	○	○	✓	✓
Total Number of features known at each time stamp		4	4	4	5	5
Actual total no. of features at each time stamp		5	5	4	4	4

- Feature is available (green checkmark)
- Feature is seen before but not available now (red X)
- Prior Information about the feature is known but the feature has not been seen before (question mark)
- No information about the feature is present, not even its existence (grey circle)

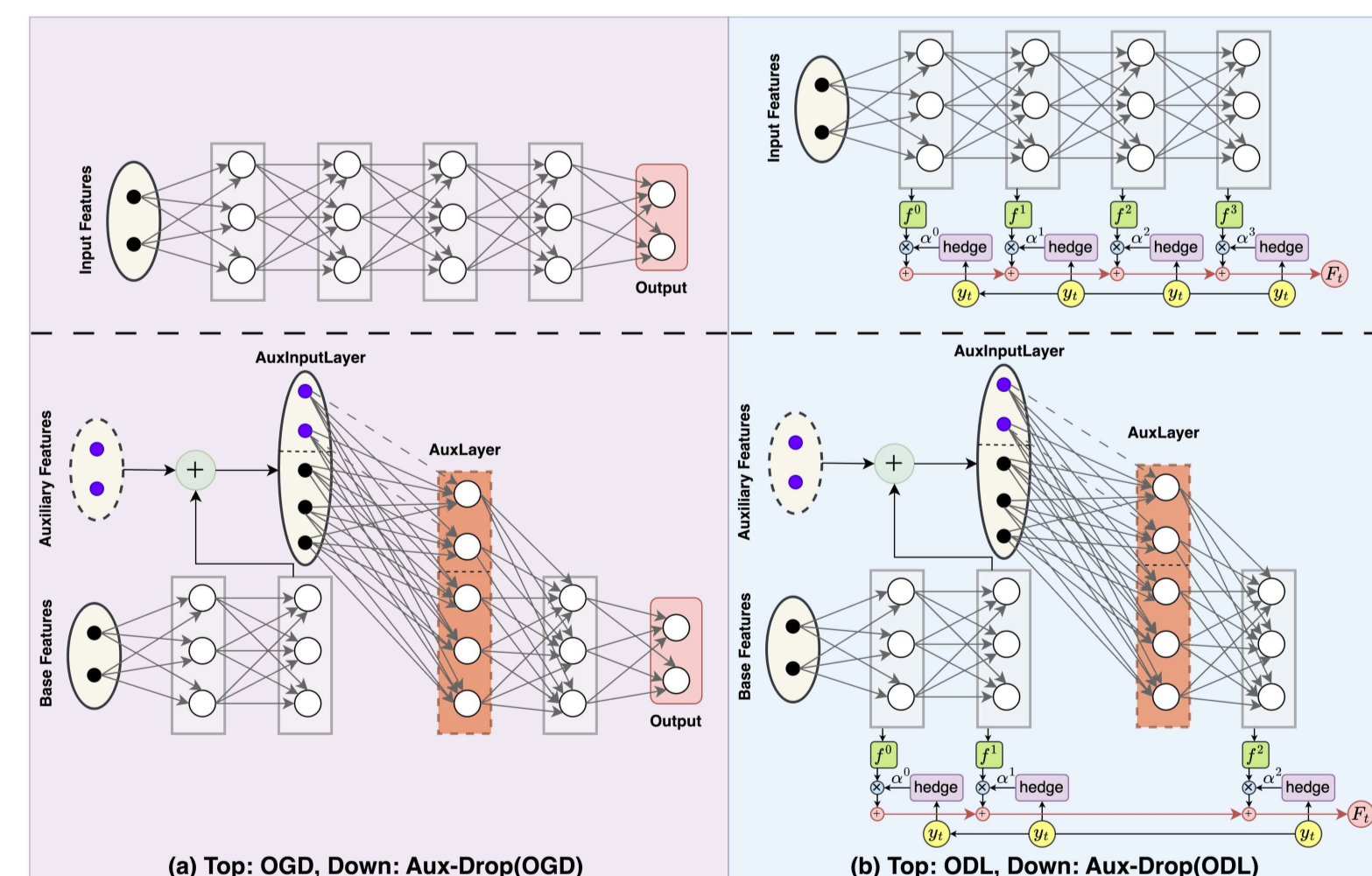
Legend

Left: An Example of Haphazard Inputs, Right: Legend

Auxiliary Dropout (Aux-Drop)



Aux-Drop Architecture

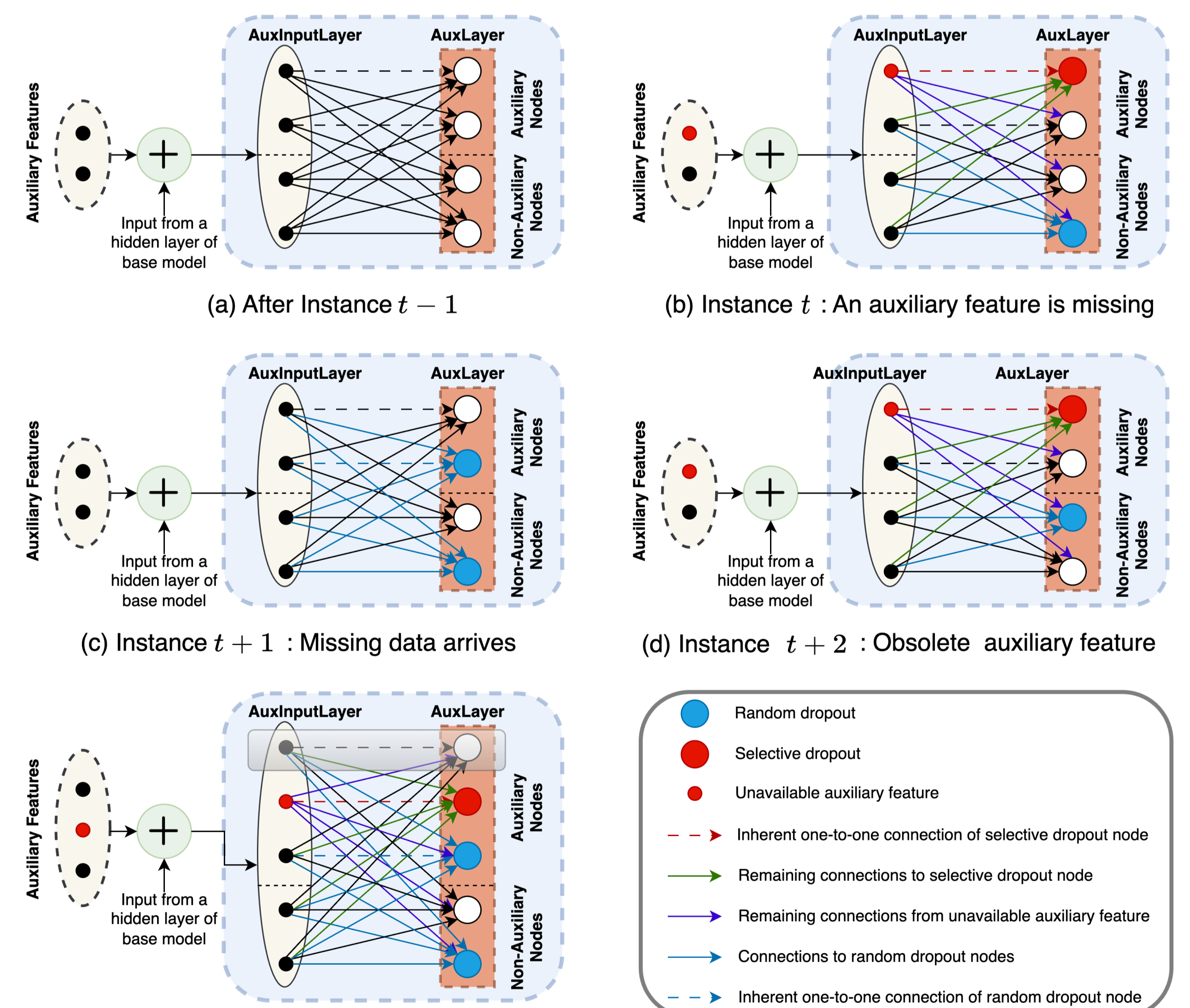


Aux-Drop is Invariant to Deep Learning Architectures

In Aux-Drop, we created a division in the passing of input features. The base features (always available) are directly passed to the first layer. A hidden layer is designated as an AuxLayer. The hidden features from the layer previous to the AuxLayer are concatenated with the auxiliary features (haphazard inputs) and are known as the AuxInputLayer. The AuxInputLayer is passed to the AuxLayer. Dropout [2] is applied only in the AuxLayer.

Selective Dropout: The number of auxiliary nodes is the same as the total number of seen auxiliary features such that there is an inherent one-to-one connection between them. Here, those auxiliary nodes are dropped whose corresponding auxiliary features are unavailable.

Random Dropout: The rest of the dropout nodes are chosen randomly from the remaining nodes.



(e) Instance $t + 3$: Sudden feature arrives

(f) Legend

Working of Aux-Drop

Results

Dataset	OLVF	Aux-Drop(ODL)	Aux-Drop(OGD)
german	333.4 ± 9.7	300.4 ± 4.4	312.8 ± 19.3
svmguide3	346.4 ± 11.6	297.2 ± 2.0	297.5 ± 1.5
magic04	6152.4 ± 54.7	5536.7 ± 59.3	5382.8 ± 98.9
a8a	8993.8 ± 40.3	6710.7 ± 117.8	7313.5 ± 277.7

Comparison with OLVF [3]. Here, all the errors reported are as the mean and std of 20 experiments on 75% availability of the data.

References

- Sahoo, Doyen, et al. "Online Deep Learning: Learning Deep Neural Networks on the Fly." Proceedings of the 27th International Joint Conference on Artificial Intelligence. 2018.
- Hinton, Geoffrey E., et al. "Improving neural networks by preventing co-adaptation of feature detectors." arXiv preprint arXiv:1207.0580 (2012).
- Beyazit, Ege, Jeevithan Alagurajah, and Xindong Wu. "Online learning from data streams with varying feature spaces." Proceedings of the AAAI Conference on Artificial Intelligence. Vol. 33. No. 01. 2019.
- Agarwal, Rohit, et al. "Aux-Drop: Handling Haphazard Inputs in Online Learning Using Auxiliary Dropouts." Transactions on Machine Learning Research (2023).