Dropout as a Bayesian Approximation: Representing Model Uncertainty in Deep Learning

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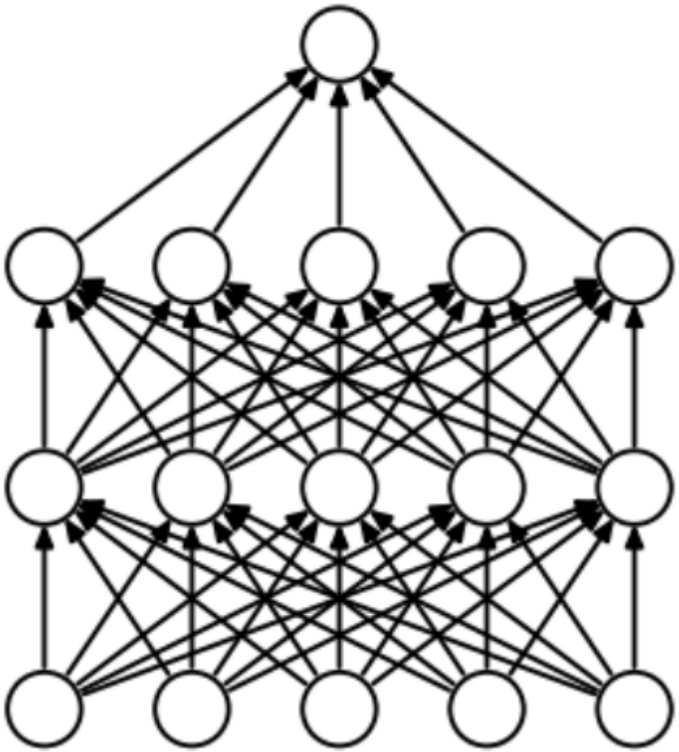
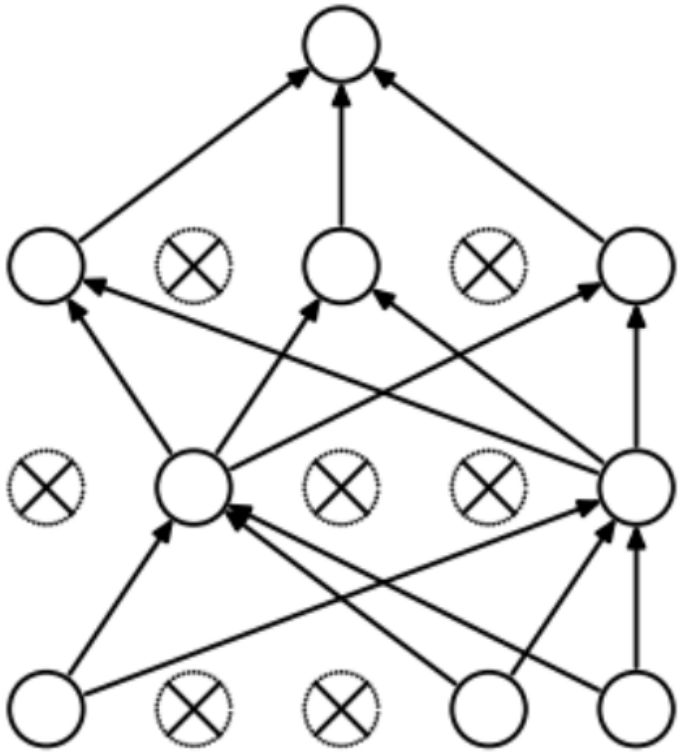
Dropout



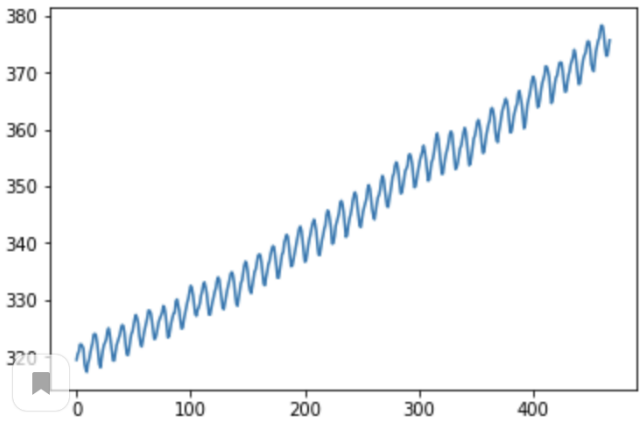
(a) Standard Neural Net

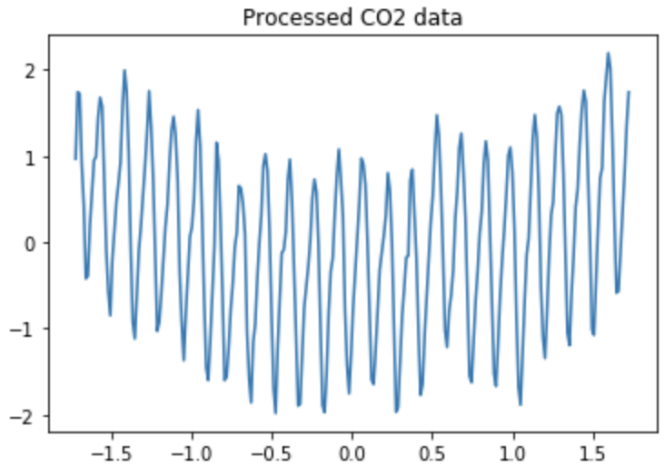


(b) After applying dropout.

Regression: CO2

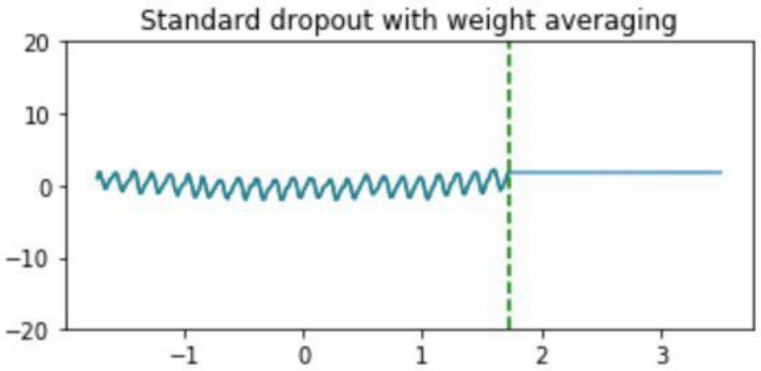
- CO2 dataset

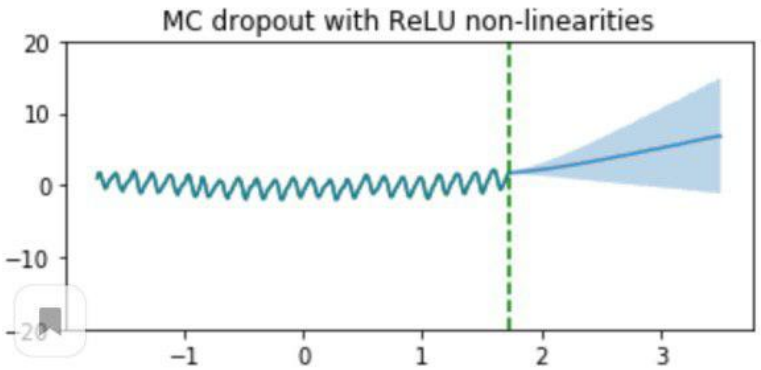


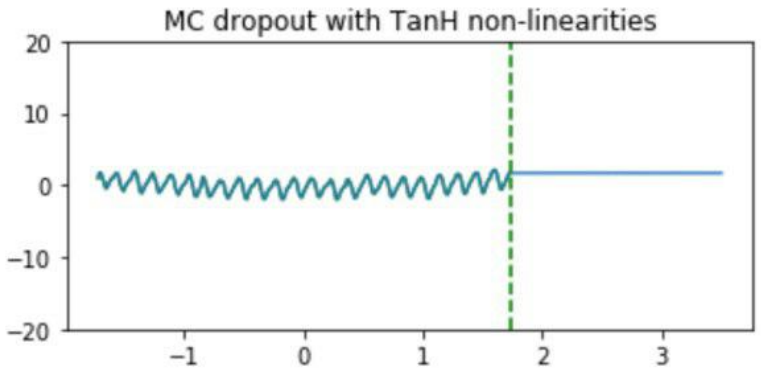


Regression: CO2

- 4 fully connected layers (1024 neurons)
- Dropout (p=0.2) after every layer
- ReLU and Tanh non-linearities

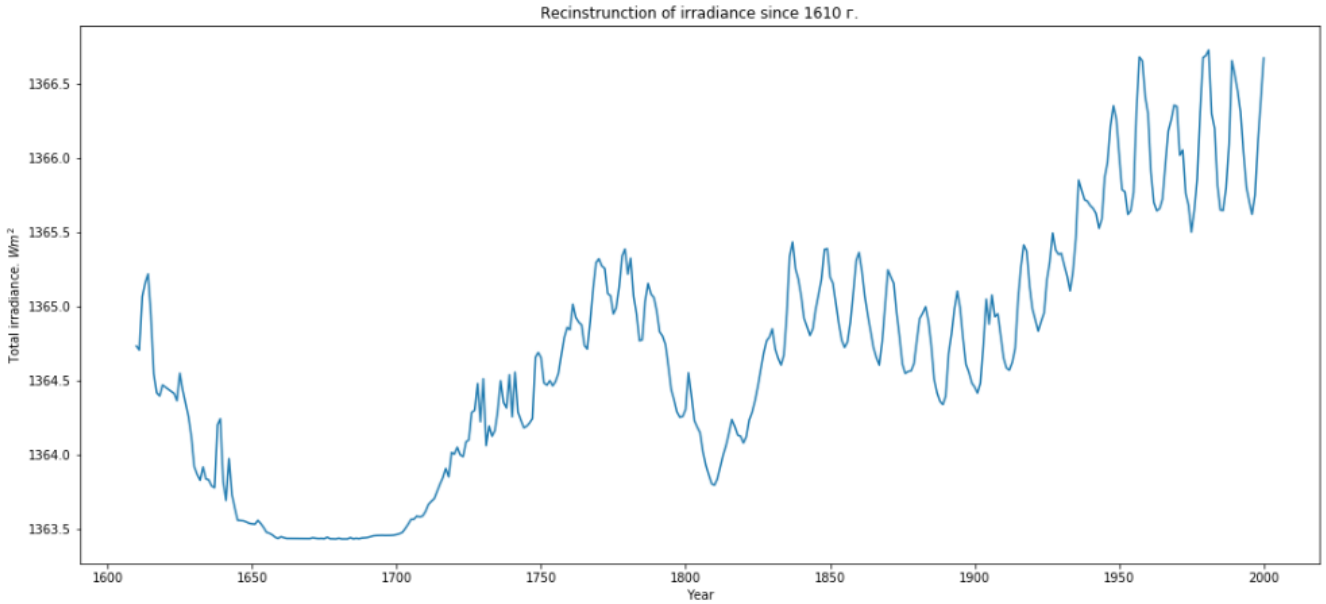






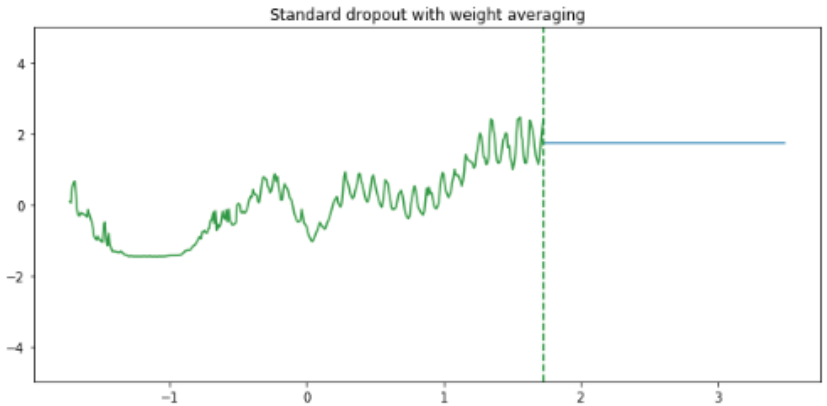
Regression: irradiance

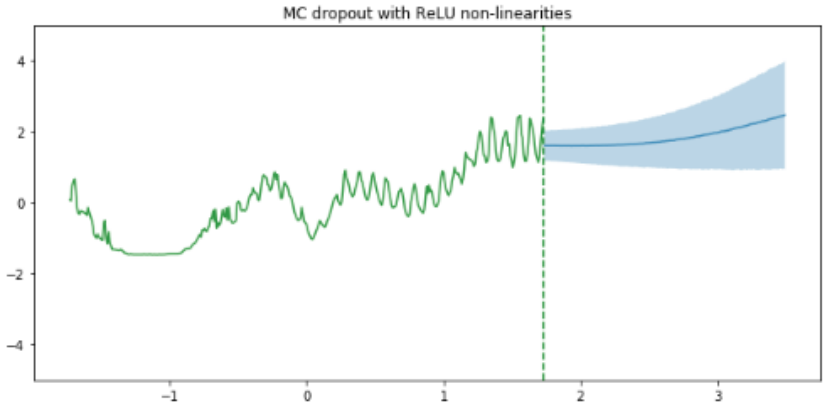
- Irradiance reconstruction dataset since 1610.

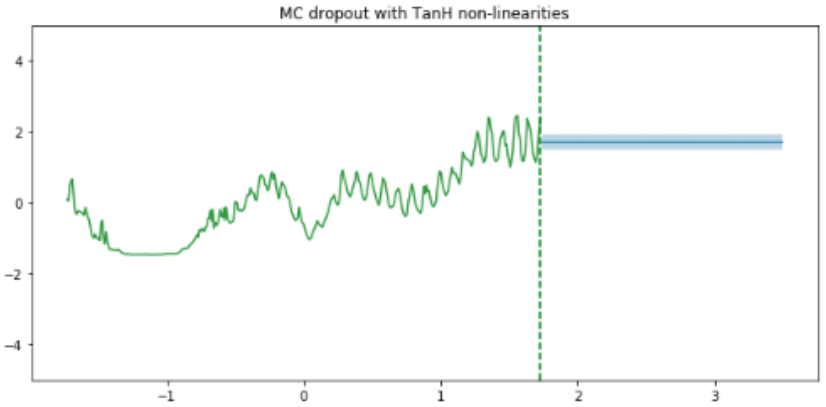


Regression: irradiance

- 5 fully connected layers (1024 neurons)
- Dropout (p=0.2) after every layer
- ReLU and Tanh non-linearities





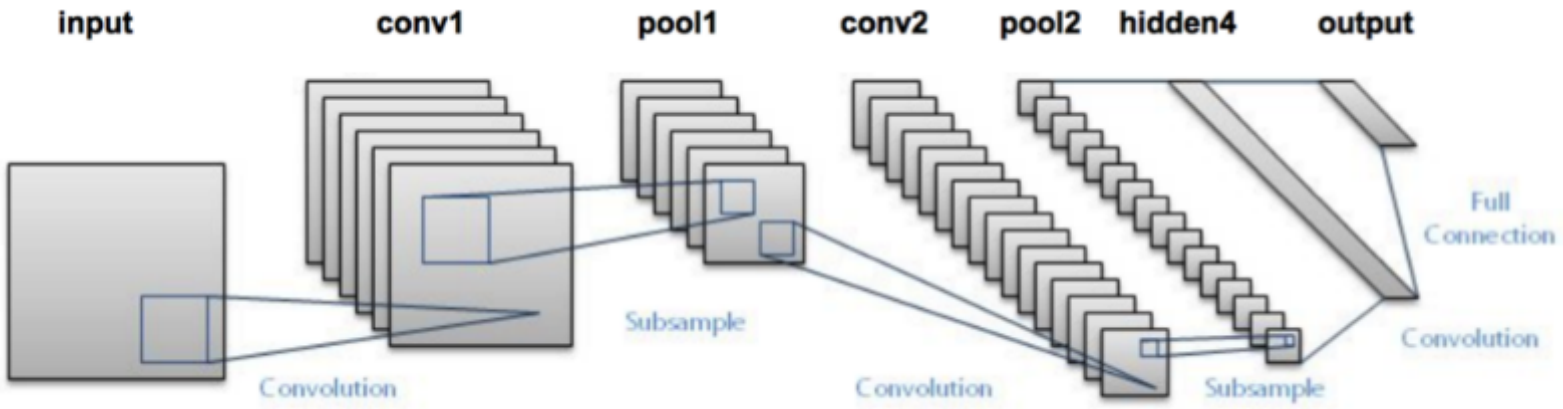


RMSE and LL

			RMSE		*LL*	
Dataset	N	Q	**PBP**	**Dropout**	**PBP**	**Dropout**
Lean2000 irradiance	391	1	0.25	0.28	−1.79	−1.87

Experiment setup

- LeNet architecture trained on MNIST dataset

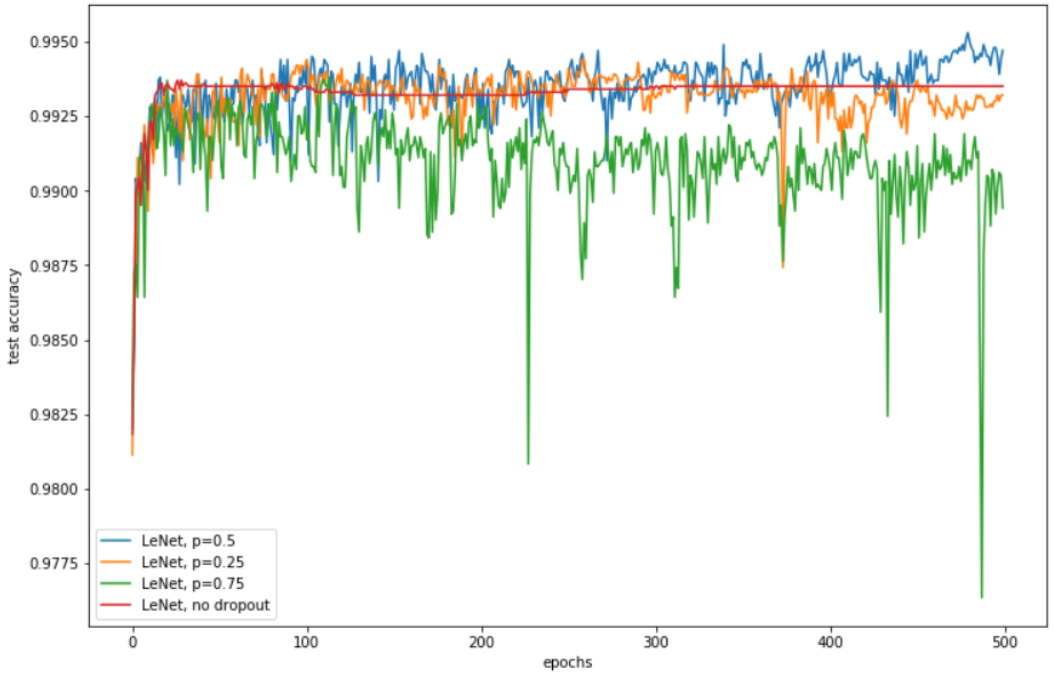


- added dropout layer before the output layer. Used p: 0, 0.25, 0.5, 0.75
- bs=32, lr=5e-3, 500 epochs, SGD (momentum=0.9, w decay=1e-6)
- lr policy:

$$\mathrm{lr}_i = \mathrm{lr}_{\mathrm{init}}(1 + \alpha i)^{-\beta}$$

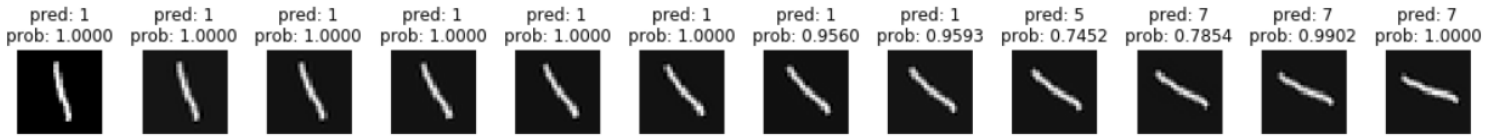
with $\alpha = 1e-4$, $\beta = 0.75$

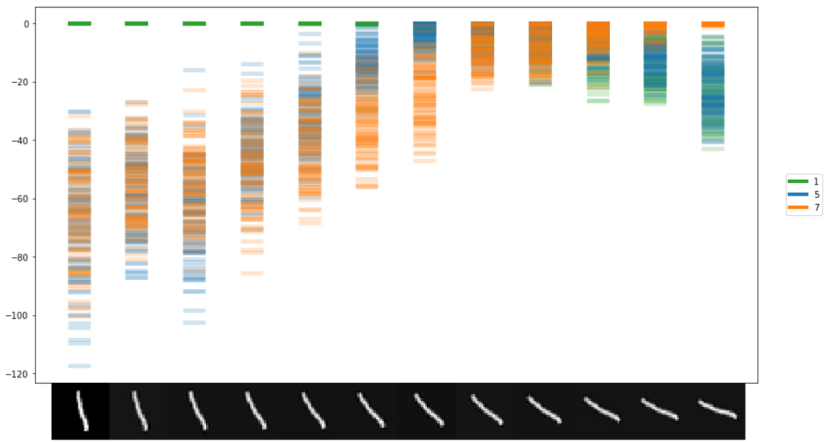
Results: test accuracy

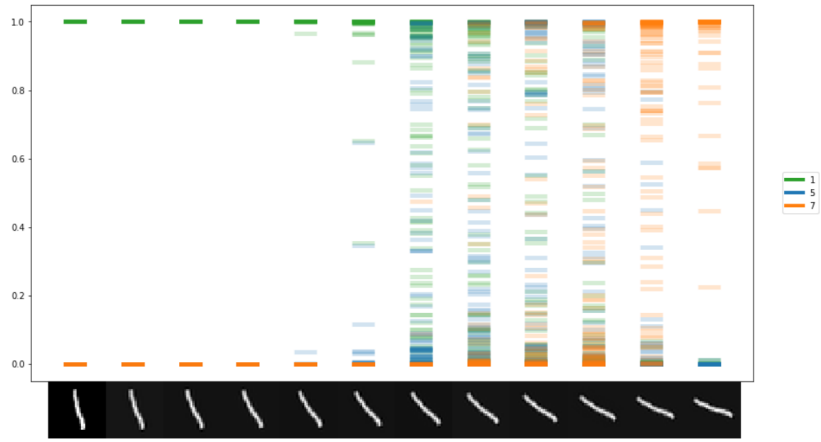


Model	accuracy	best epoch
LeNet, p=0.5	**0.995308**	479
LeNet, p=0.25	0.994409	100
LeNet, p=0.75	0.993810	113
LeNet, no dropout	0.993710	26

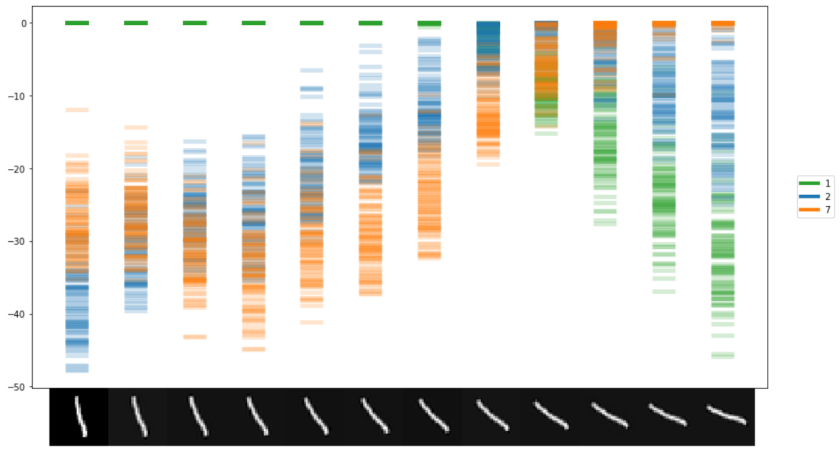
Model uncertainty: p=0.5

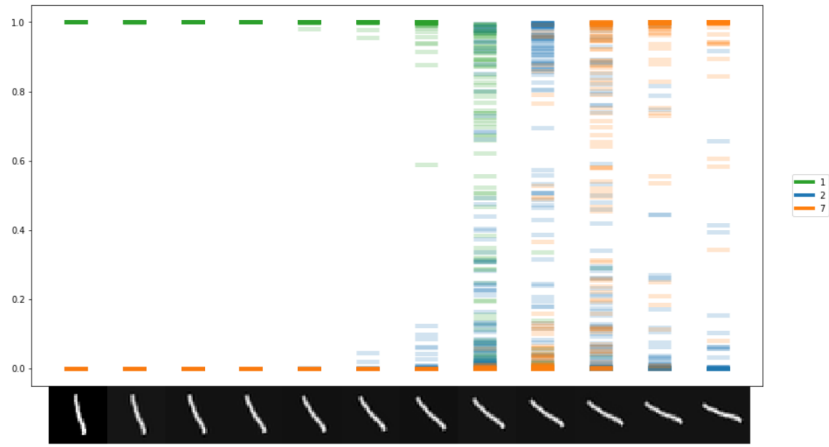




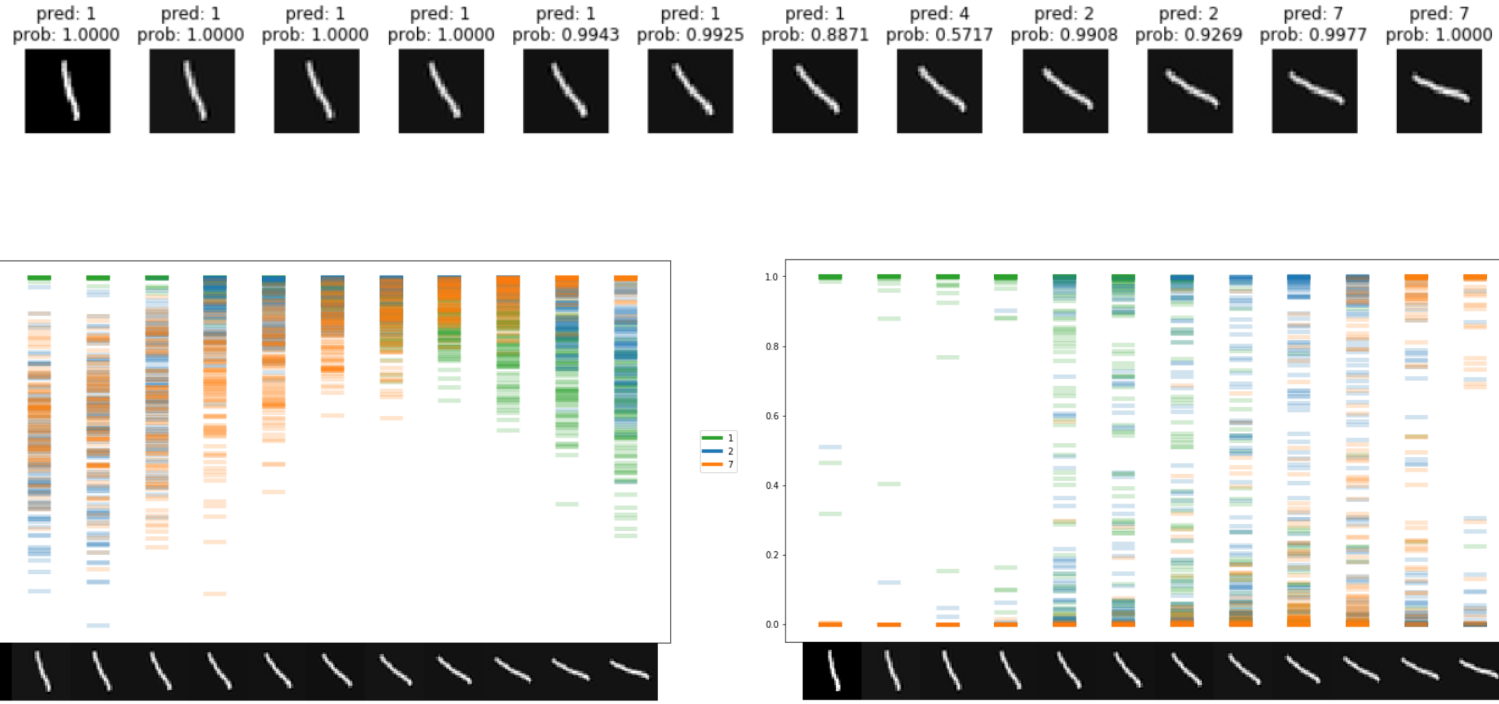


Model uncertainty: p=0.25





Model uncertainty: p=0.75



Conclusion

In this work we studied how such regularization technique as dropout can be applied in order to represent model uncertainty. We implemented the experiments from the studied paper and compared the uncertainty of different models in regression and classification tasks. We also explicitly shown the importance of uncertainty estimation in classification task.

References

1. Y. Gal, Z. Ghahramani. Dropout as a Bayesian Approximation: Representing Model Uncertainty in Deep Learning. *arXiv:1506.02142*, 2016.
2. https://github.com/blacKitten13/Dropout-for-Model-Uncertainty