DNN Surrogate for Solving PDES with Spatially Varying Coefficients

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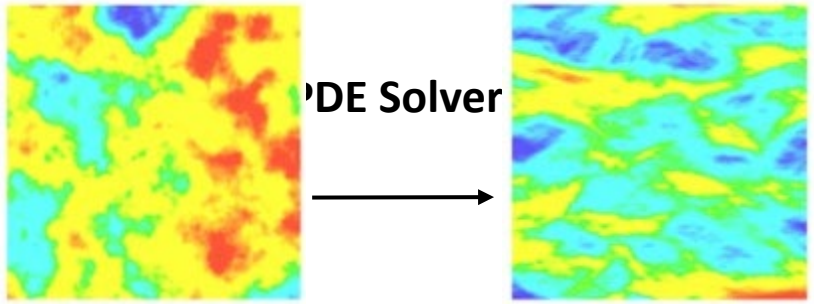
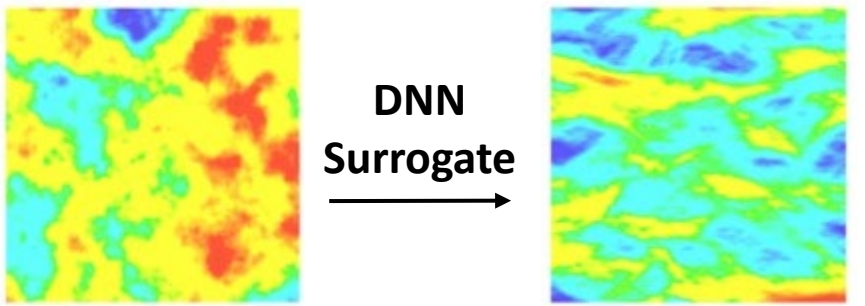
Motivation

- PDE with spatially varying but uncertain coefficients. Want to characterize uncertainty in the output using (e.g.) MC methods.



Random Field *Random Solution*



Random Field *Random Solution*

Drawbacks:

- The PDE solver is very expensive (esp. if input is high dimensional)
- Need thousands of forward solves to obtain convergent statistics

Benefits:

- Trained surrogate is cheaper to evaluate
- Outputs from the surrogate have same distribution as outputs from PDE solver

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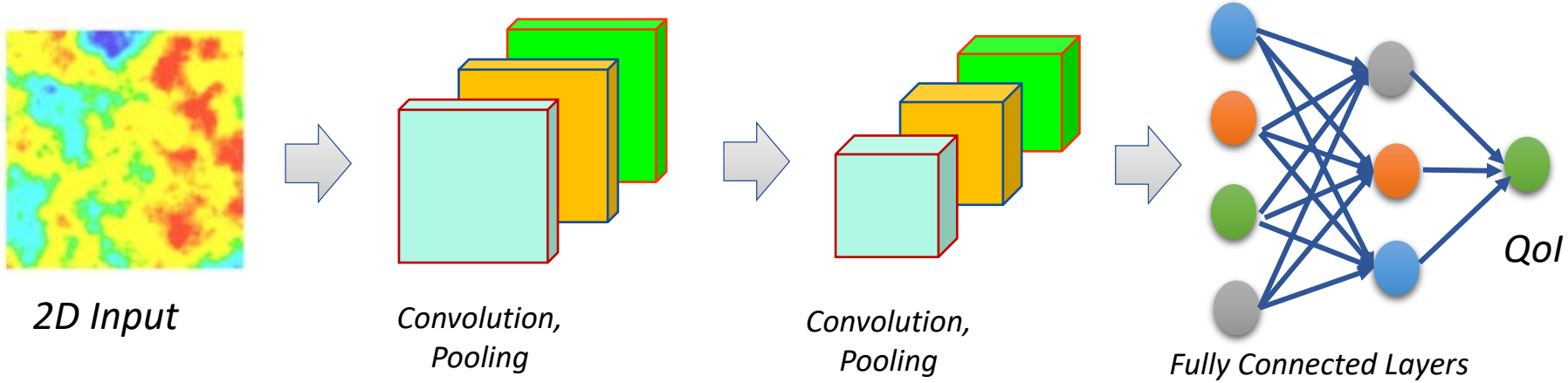
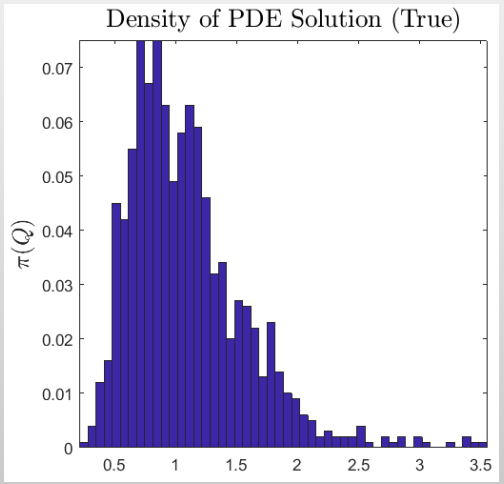
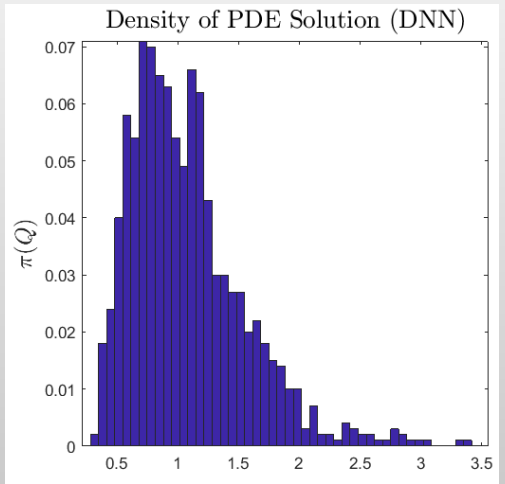
Methods & Preliminary Results

- Trained a convolutional neural network with fully connected layers



	Q True	Q Test	Q Diff
Mean	1.0934	1.0770	0.01633
Median	1.0123	0.9937	0.01569
St. Dev	0.4817	0.4720	0.05225
Range	3.2711	3.0494	0.8074





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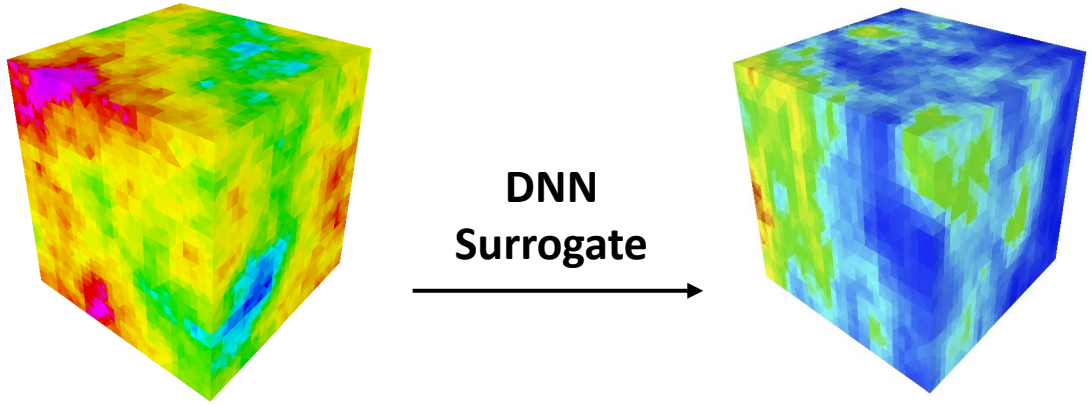
Future Work



Random Permeability Field

Random Velocity Field

- Apply the surrogate to problems with 3D random-field inputs
- Utilize DNN surrogates to accelerate Bayesian inference

References:

- **X. Lou and A. Kareem** *Deep convolutional neural networks for uncertainty propagation in random fields*. Computer Aided Civil and Infrastructure Engineering (2019)
- **R.K. Tripathy and I. Bilionis** *Deep UQ: Learning deep neural network surrogate models for high dimensional uncertainty quantification*. Journal of Computational Physics (2018) 565-588.

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