Non-Parametric Transformation Networks
For Learning General Invariances from Data

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Motivation

To be invariant to nuisance transformations in data, we would require

- **Knowledge** of the added transformations apriori
- **A different network architecture** invariant for each nuisance transformation (inductive bias)

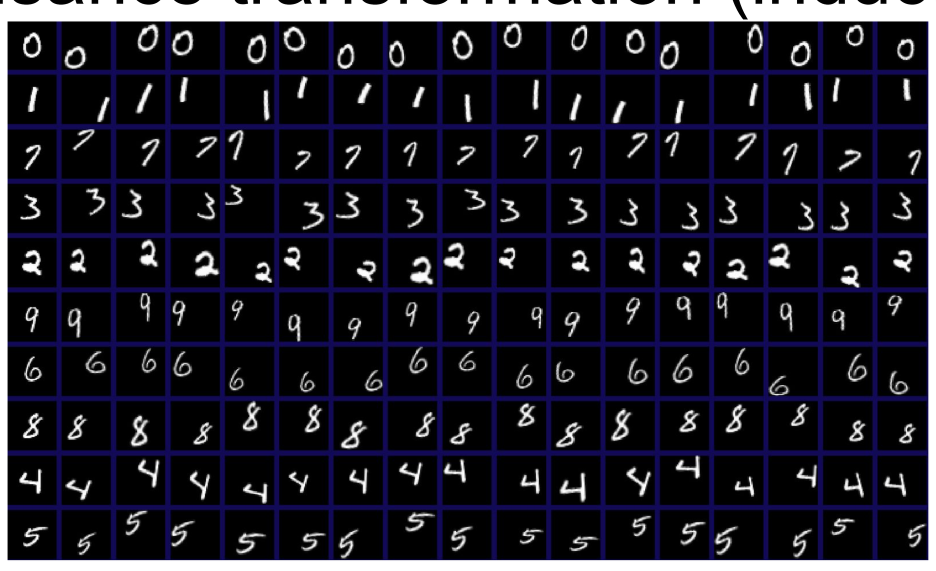
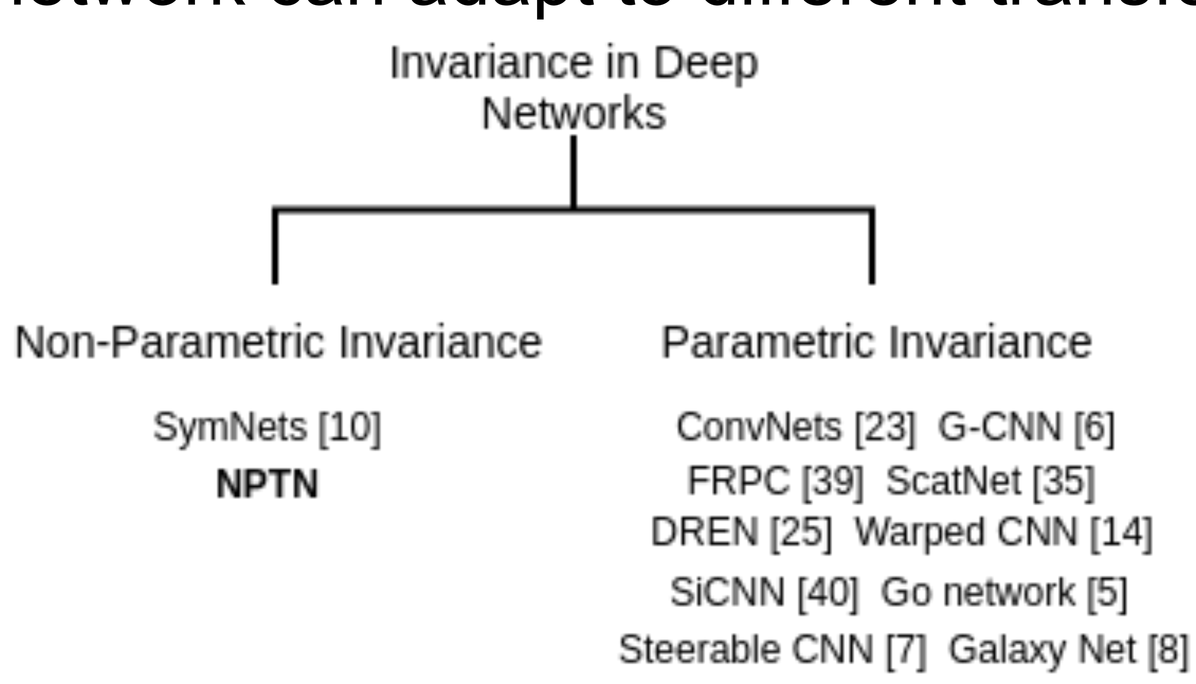


Fig. Example data with nuisance transformations.

NPTNs address both issues:
No apriori knowledge of nuisance transformations is required.
No change in architecture required. The exact same network can adapt to different transformations



The **Transformation Network (TNs)** framework is a generalization of convolutional architectures which describes *networks which can be invariant to transformations in a set G.*

TNs and NPTNs

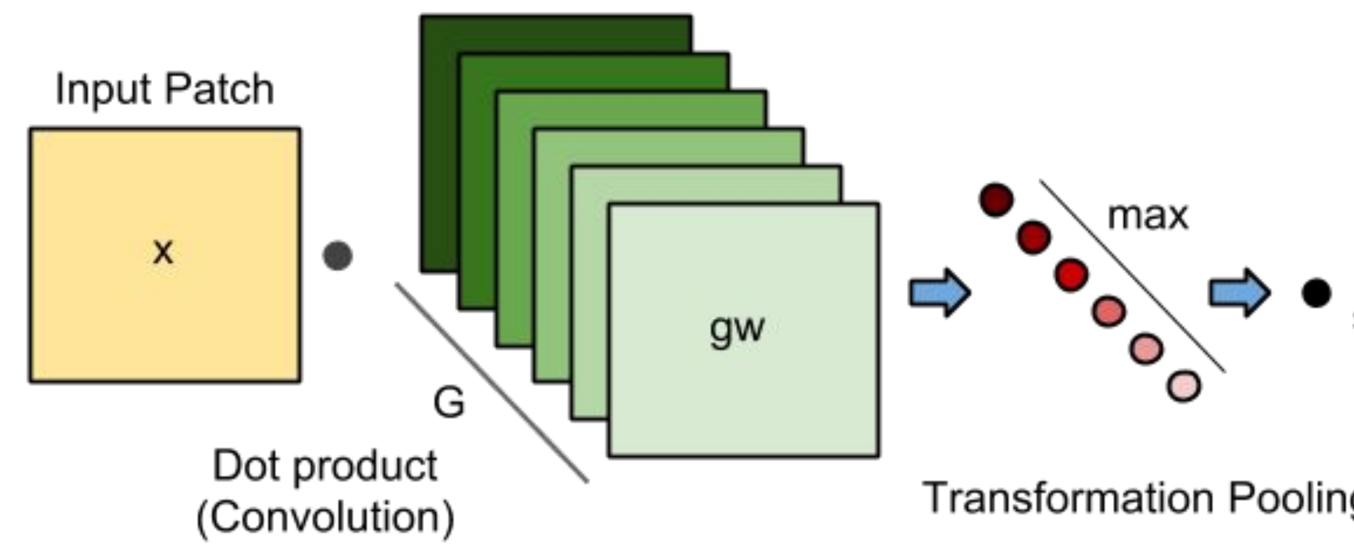


Fig Above. A single Transformation Network node (one input channel and one output channel). Non-Parametric Transformation Network (NPTN) node has the same structure.

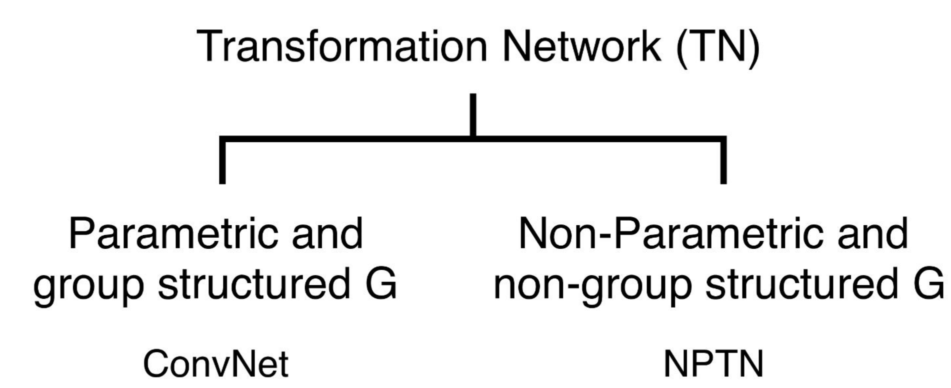
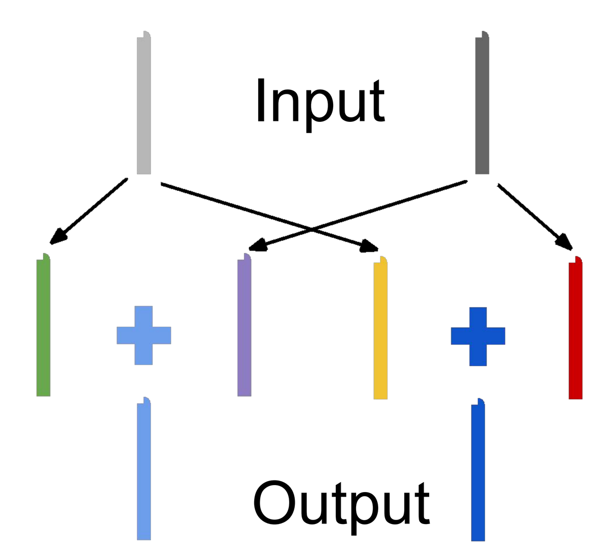


Fig Right. A vanilla Convolution layer with 2 input 2 output channels.



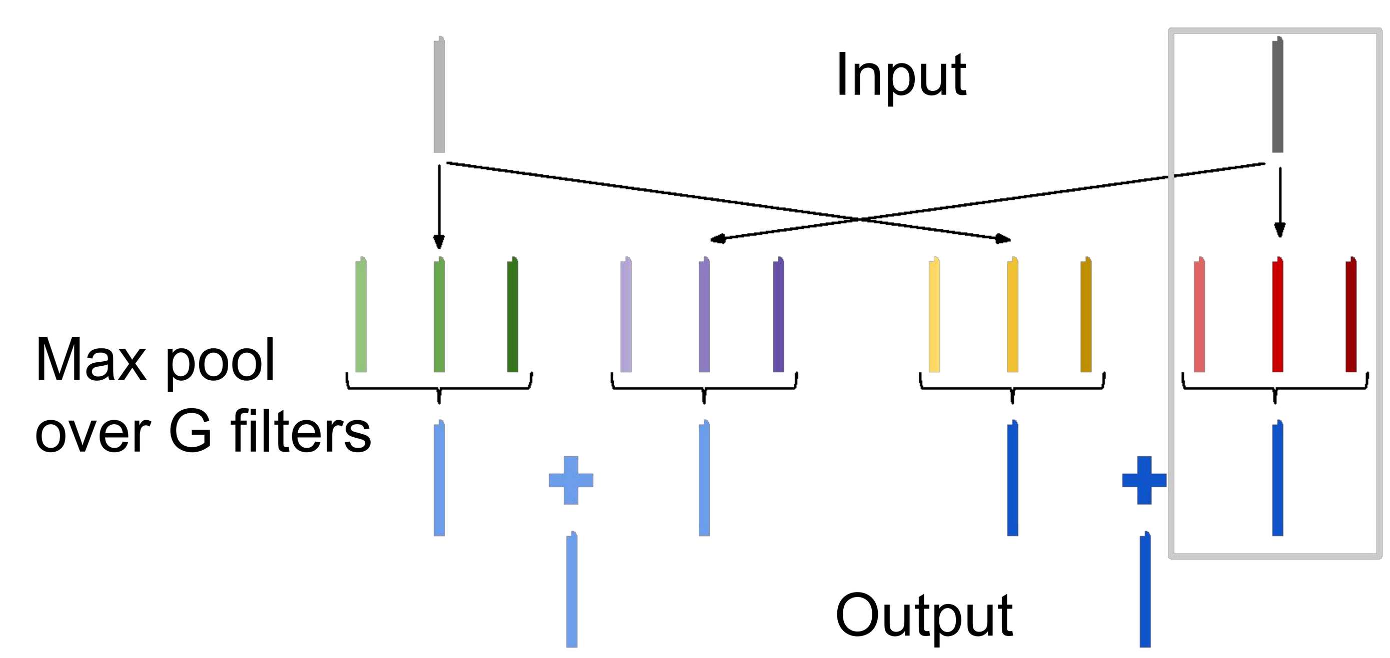
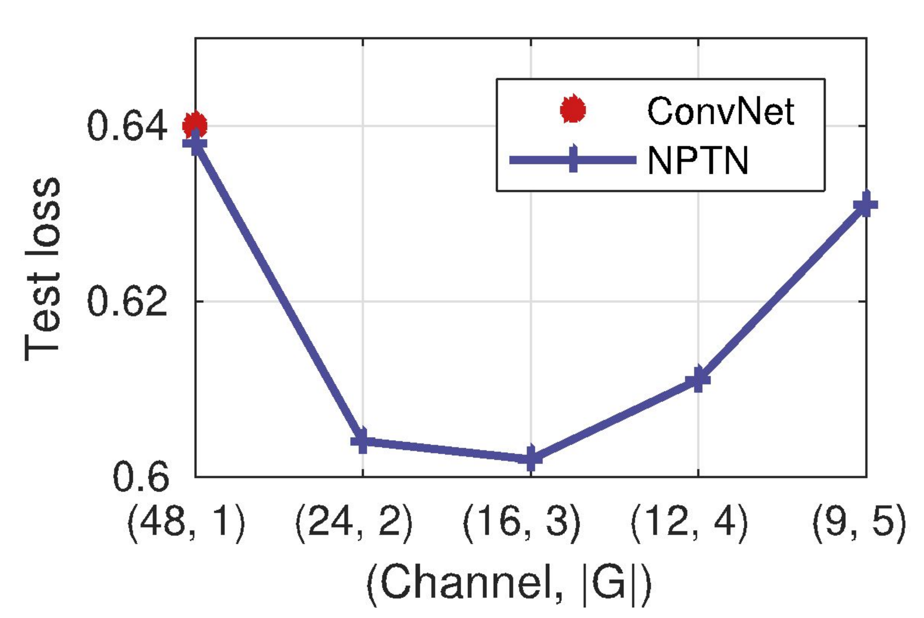


Fig Above. A NPTN layer with 2 input 2 output channels. Grey box depicts a single NPTN node (as same top most figure).

Experimental Validation



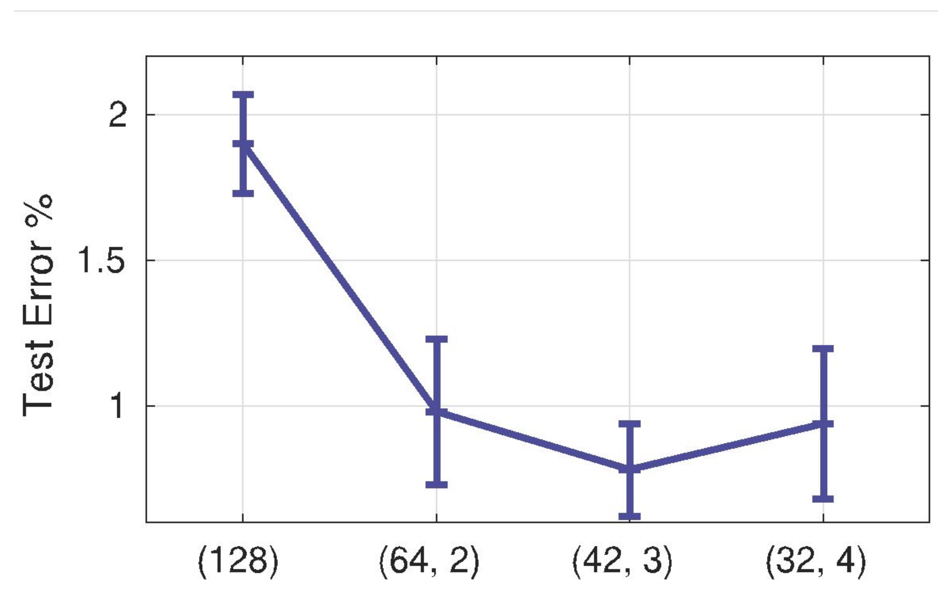


Fig. Left Top. Test error on CIFAR 10. **Left Bottom.** Test error on MNIST with Capsule nets with NPTN layers. **Right**. Test error on progressively transformed MNIST with (a) random rotations and (b) random pixel shifts during testing. Capsule Networks. (Channel, G): Channel is number of channels in the middle layer, G is the [illegible] oled over.

QR code for the arxiv version

Rotations	0°	30°	60°	90°
ConvNet (36)	0.75	1.16	2.05	3.32
NPTN (36, 1)	0.68	1.27	2.01	3.36
NPTN (18, 2)	0.66	1.09)	1.72	2.88
NPTN (12, 3)	**0.63**	**1.08**	**1.71**	**2.76**
NPTN (9, 4)	0.66	1.17	1.83	2.94
Translations	**0 pix**	**4 pix**	**8 pix**	**12 pix**
ConvNet (36)	0.62	0.95	1.97	7.00
NPTN (36, 1)	**0.62**	0.88	1.84	7.22
NPTN (18, 2)	0.74	0.75	1.70	6.26
NPTN (12, 3)	0.66	**0.70**	**1.58**	**6.20**
NPTN (9, 4)	0.64	0.76	1.59	6.37