NRI: A New Paradigm for Geometric Reasoning through Structure from Category

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Challenge

- 2D labels are cheap and easy to obtain, however, 3D labels are onerous; as they require association with an external 3D shape.

Broader Impact

- Simplifying how 3D labels can be obtained will dramatically improve how robots and AIs can geometrically reason about the world.

- Outputs to be integrated into a new course graduate level course on Geometry in Deep Learning for Robotics.

Solution

- To recover 3D labels solely from an ensemble of 2D landmarks stemming from the same object category (e.g. "chair").

- We propose to use something called "structure from category"; leveraging recent theoretical insights connecting deep learning to compressed sensing.

Scientific Impact

- Critical for innovations in autonomous transport, disaster relief, endangered species preservation, and space exploration.

$\mathbf{W} \in \mathbb{R}^{3 \times P}$ $\boldsymbol{\theta} \in \mathbb{R}^6$ $\mathbf{X} \in \mathbb{R}^{2 \times P}$

$\pi()$ "projection function"

$\mathbf{X} = \pi\left(\mathbf{W}; \boldsymbol{\theta}\right)$

External 3D Shapes

Human Annotated 2D Labels

Ground-truth. State-of-the-art Our result.