

Equivariant Networks for Pixelized Spheres

Mehran Shakerinava, Siamak Ravanbakhsh

ICML 2021

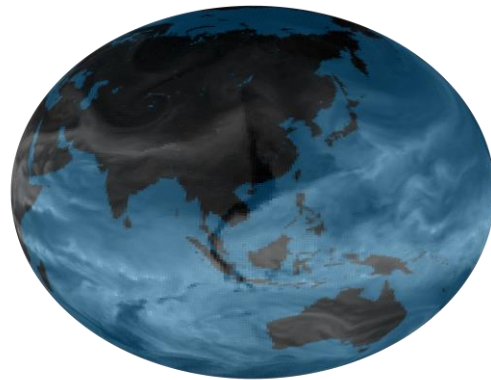


Examples of Spherical Data

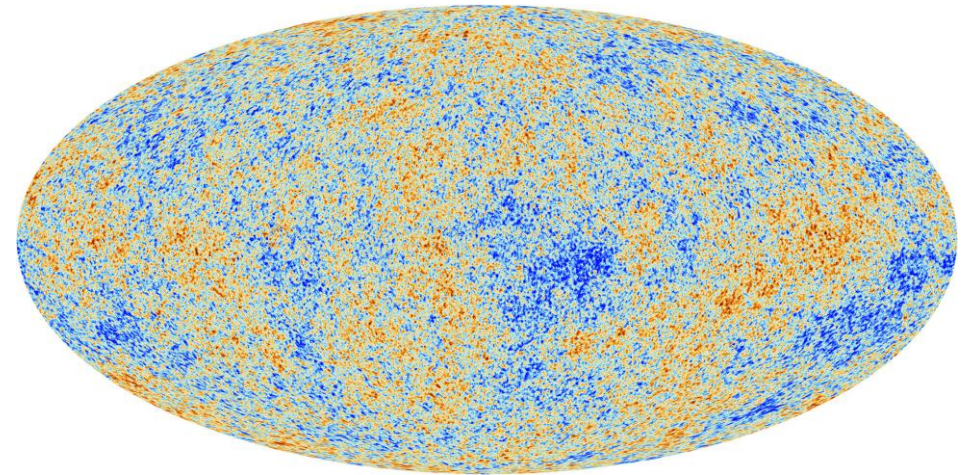
Omnidirectional Images



Climate Data

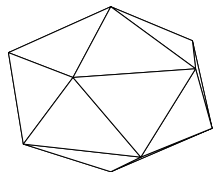
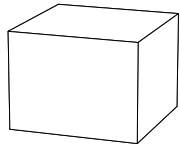
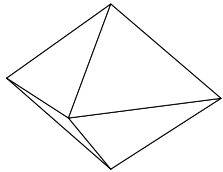
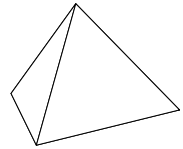


Cosmic Microwave Background Maps

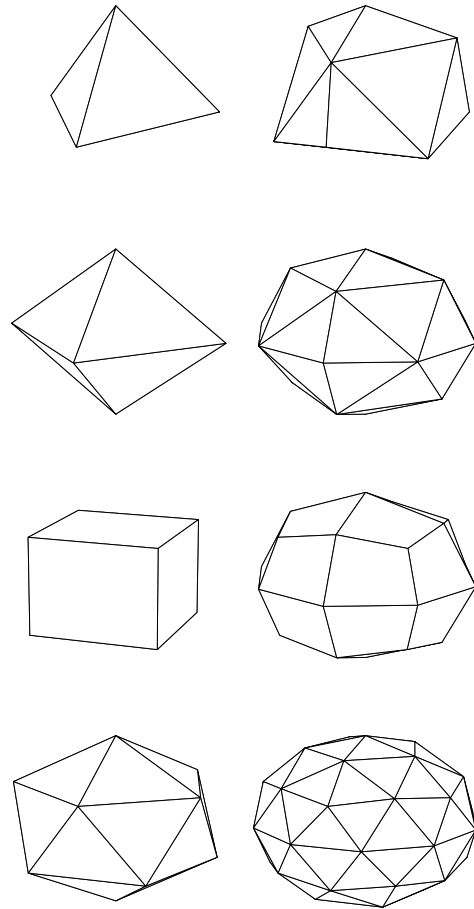


Platonic Pixelizations of the Sphere

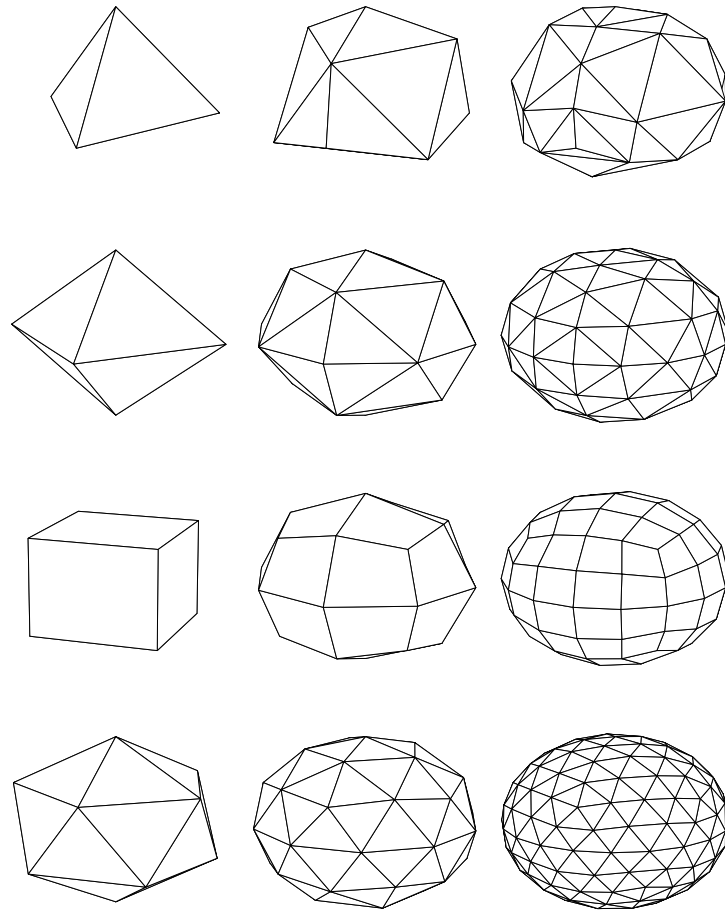
Platonic Pixelizations of the Sphere



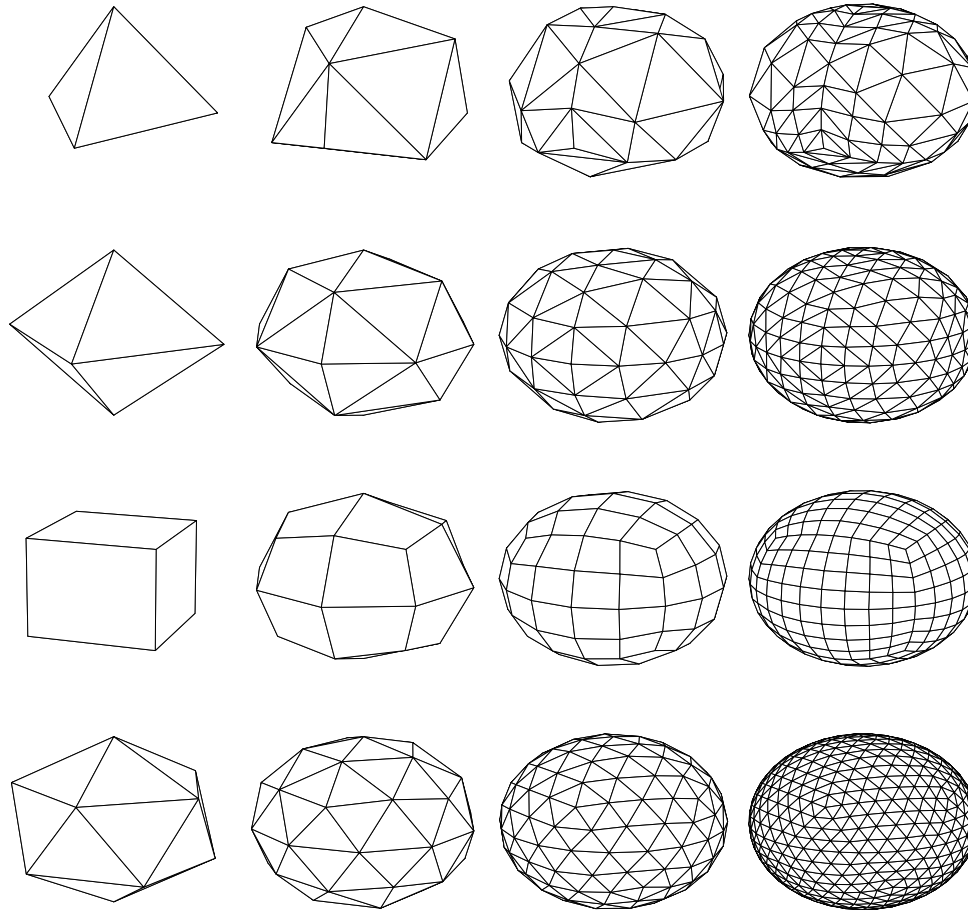
Platonic Pixelizations of the Sphere



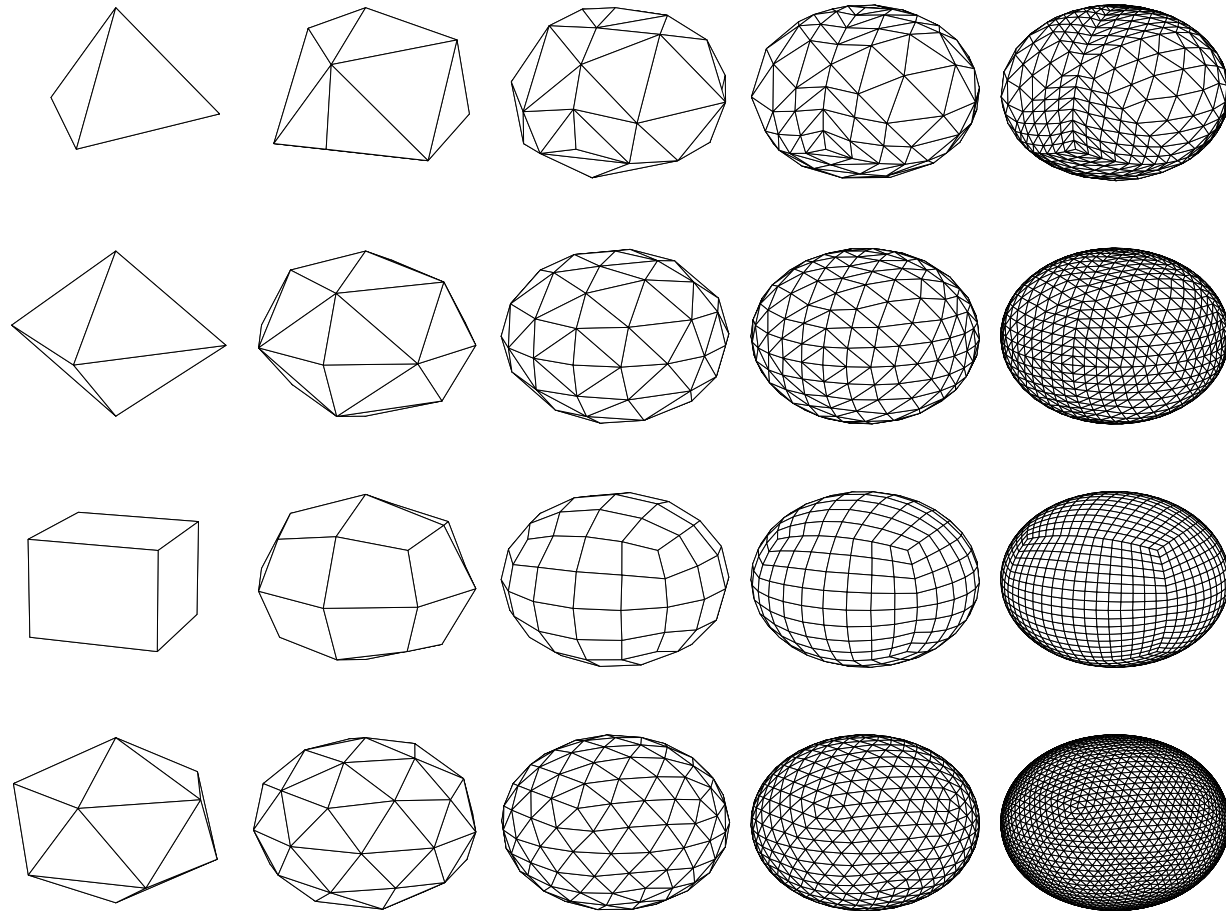
Platonic Pixelizations of the Sphere



Platonic Pixelizations of the Sphere



Platonic Pixelizations of the Sphere



Model #1

Model #1

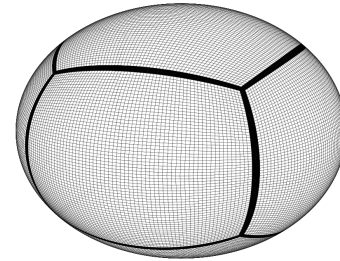
- *A hierarchy* of symmetries

Model #1

- *A hierarchy* of symmetries
- Top: permutations

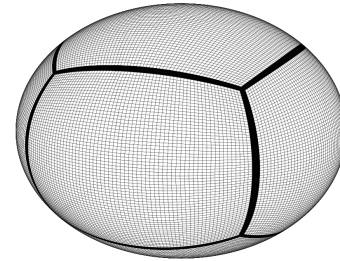
Model #1

- *A hierarchy* of symmetries
- Top: permutations



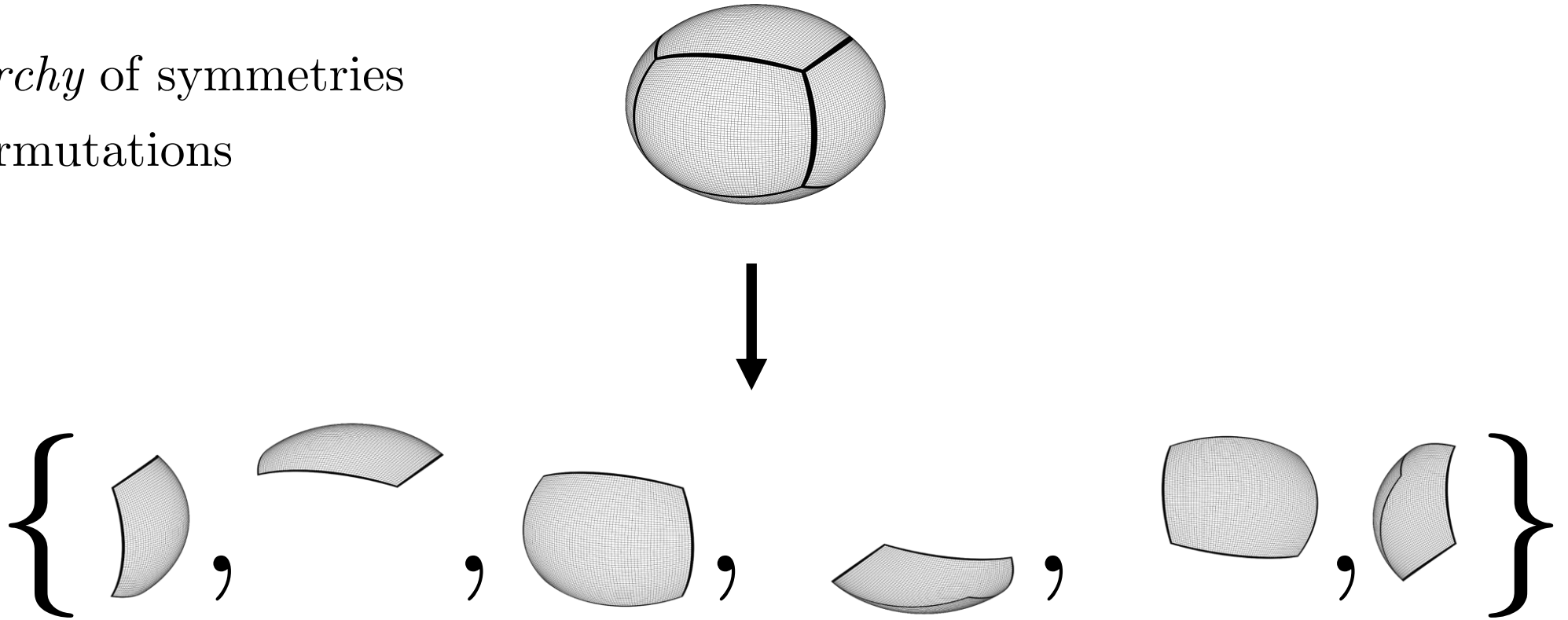
Model #1

- *A hierarchy* of symmetries
- Top: permutations



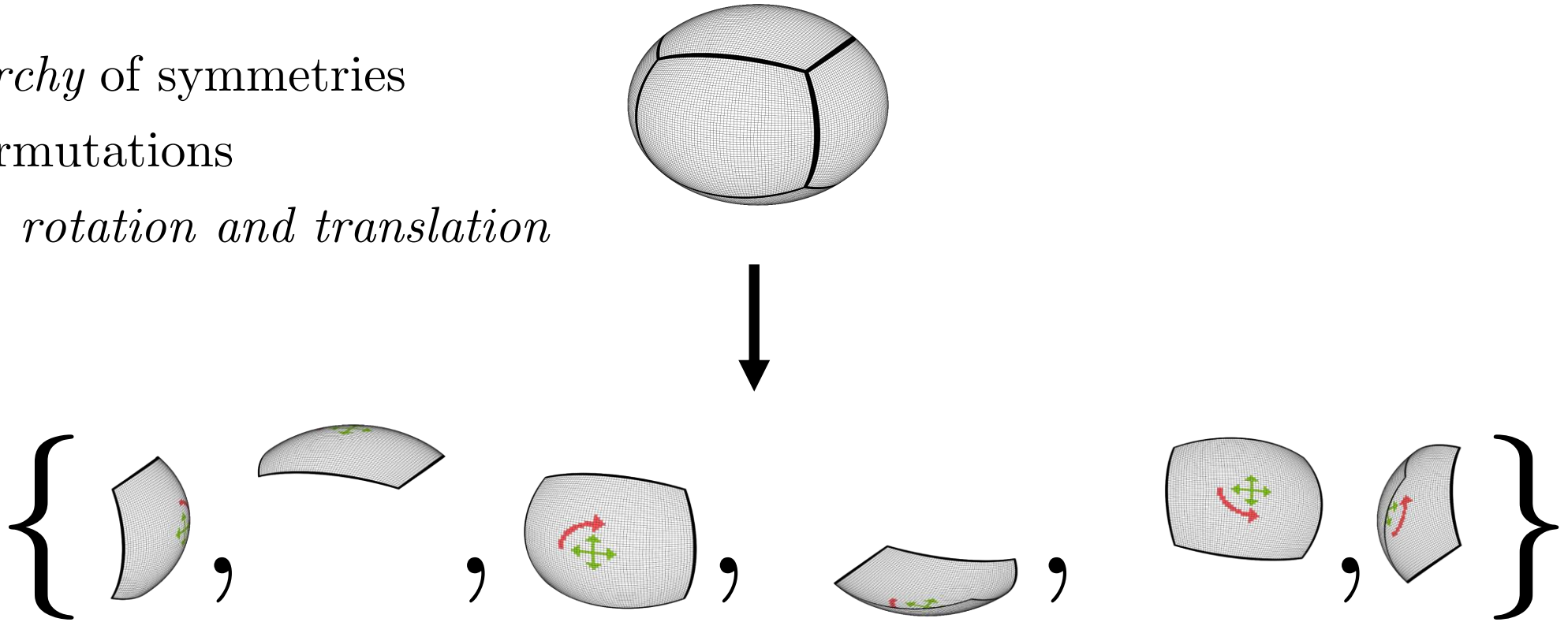
Model #1

- A *hierarchy* of symmetries
- Top: permutations



Model #1

- A *hierarchy* of symmetries
- Top: permutations
- Bottom: *rotation and translation*



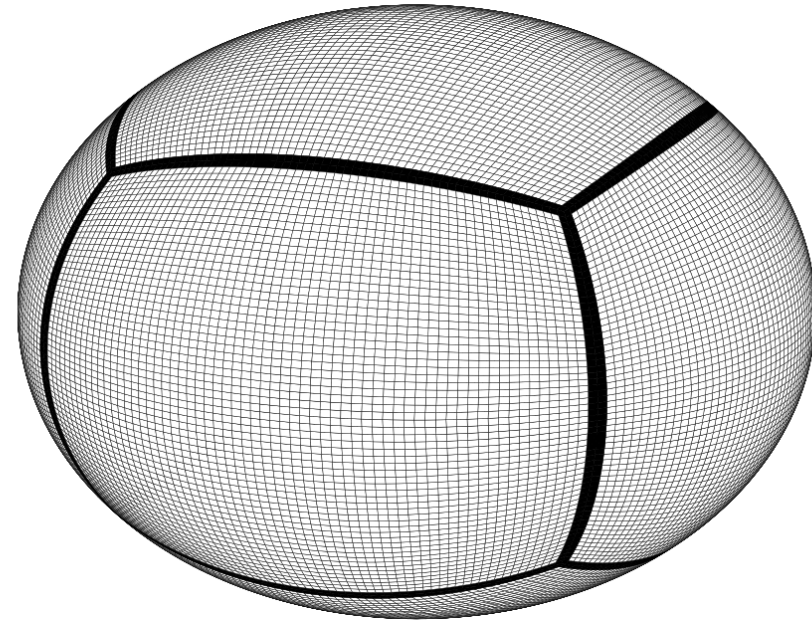
Model #2

Model #2

- *A hierarchy* of symmetries

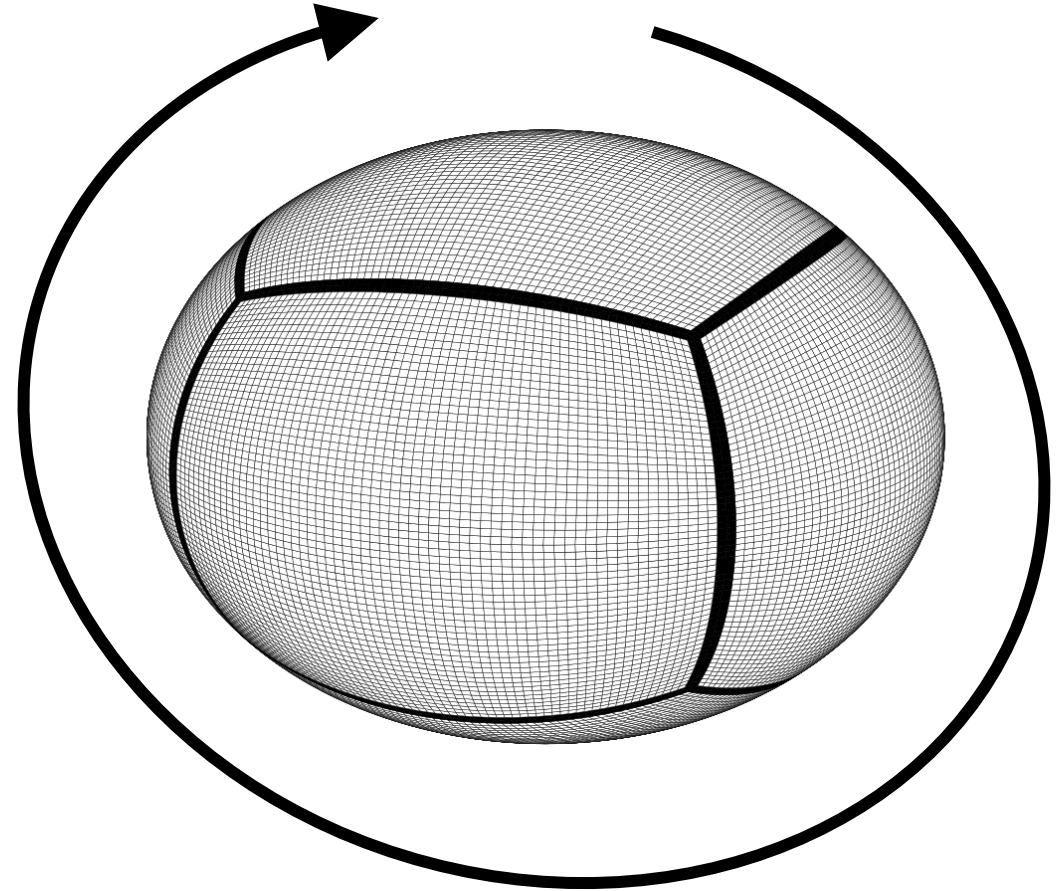
Model #2

- *A hierarchy* of symmetries
- Top: Face-symmetry of Platonic solid



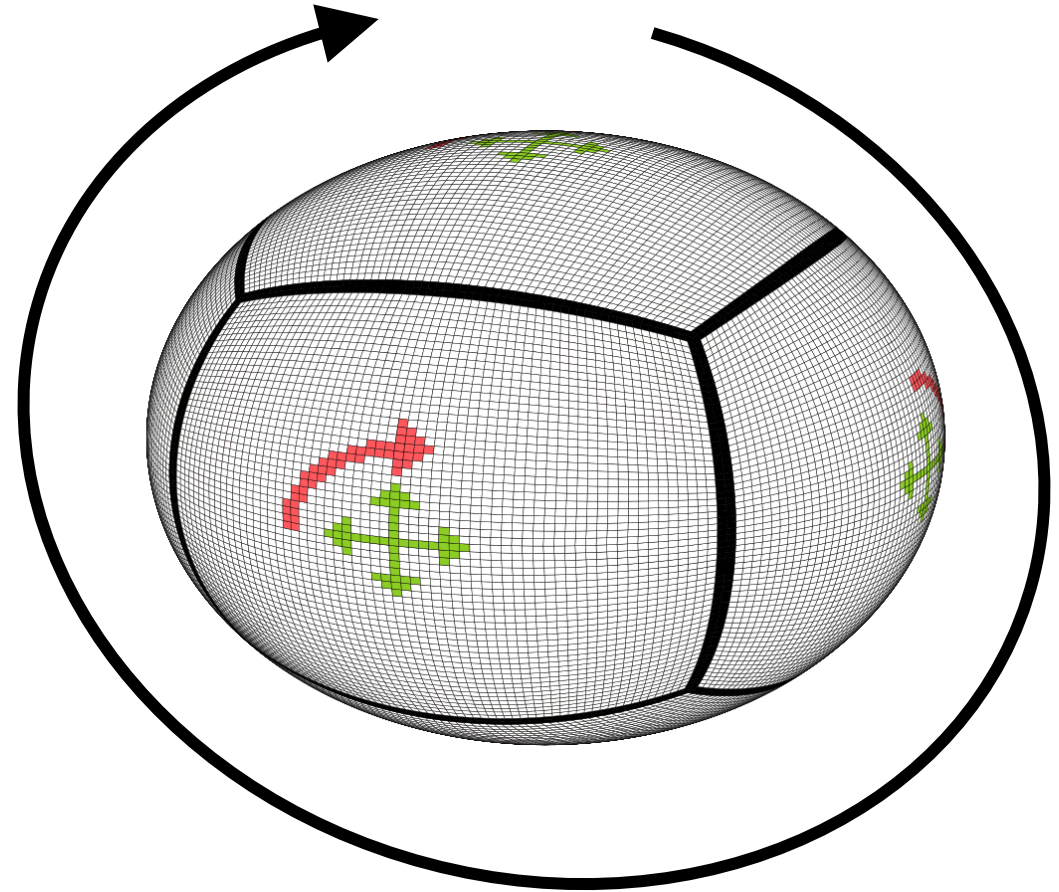
Model #2

- *A hierarchy* of symmetries
- Top: Face-symmetry of Platonic solid



Model #2

- *A hierarchy of symmetries*
- Top: Face-symmetry of Platonic solid
- Bottom: *rotation and translation*

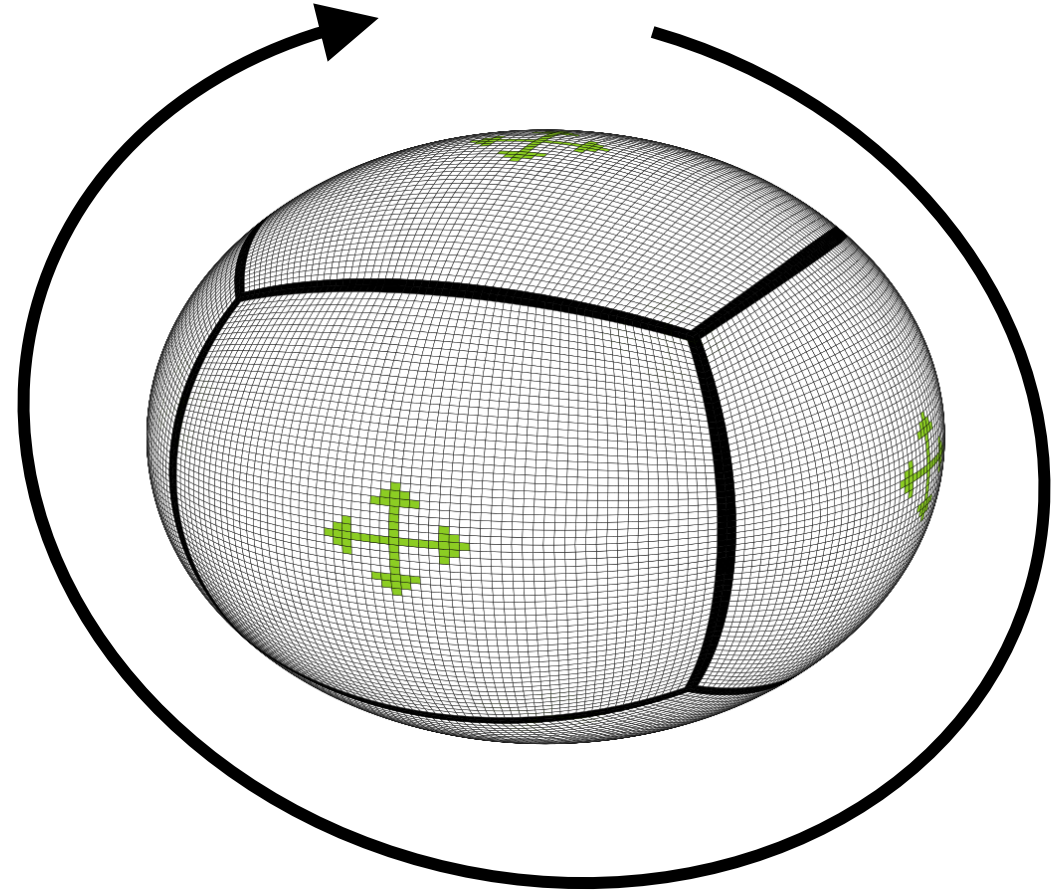


Model #3

- Faces only rotate along with Platonic solid

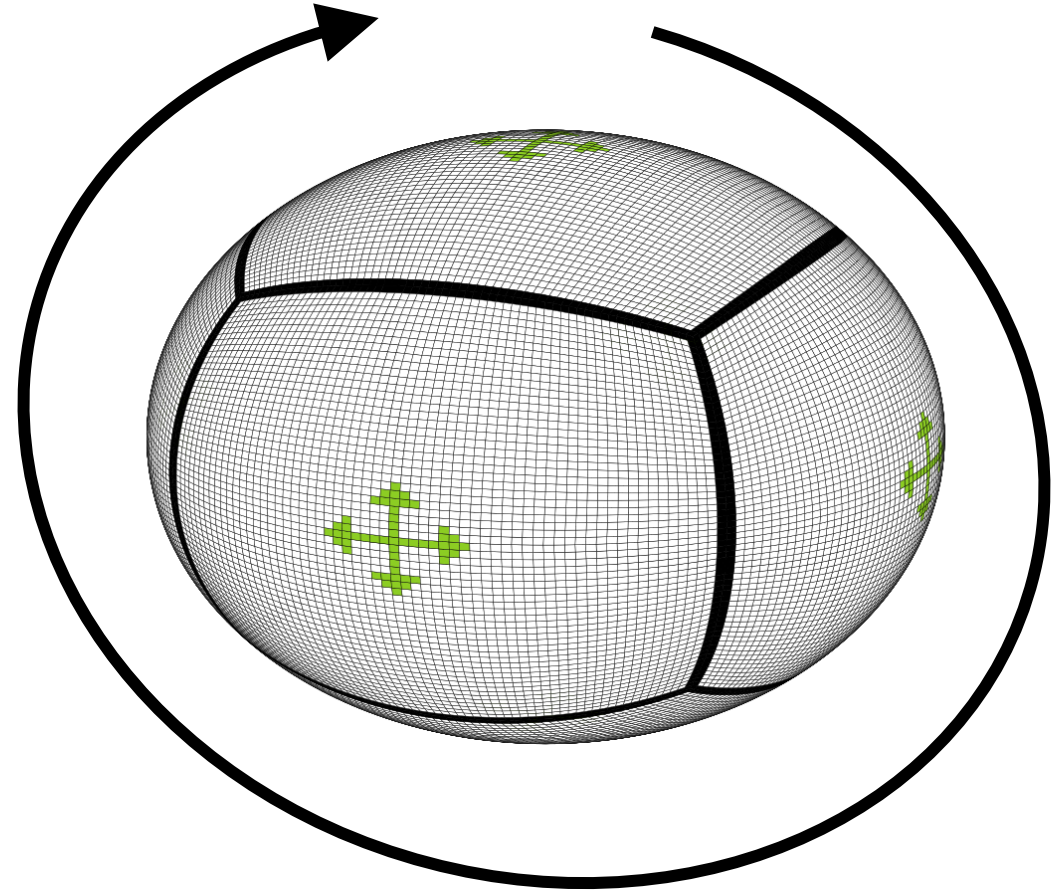
Model #3

- Faces only rotate along with Platonic solid



Model #3

- Faces only rotate along with Platonic solid
- No longer a hierarchy of symmetries



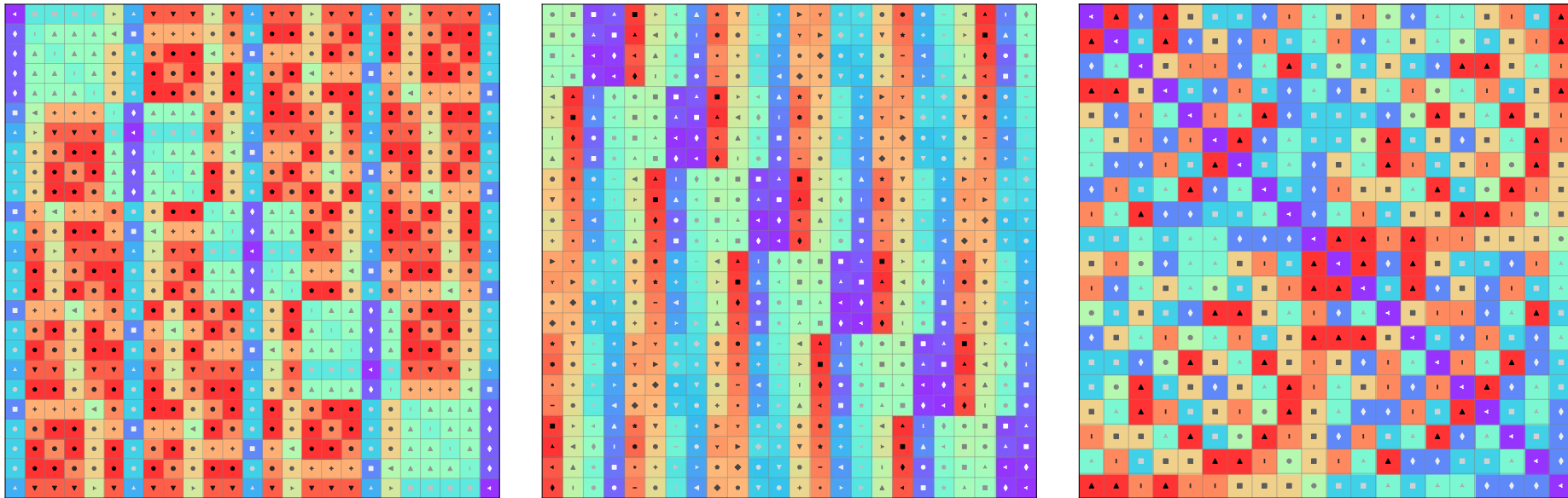
Parameter-Sharing Library (AutoEquiv)

Efficiently* construct equivariant layers for any permutation group.

**linear* time complexity

Parameter-Sharing Library (AutoEquiv)

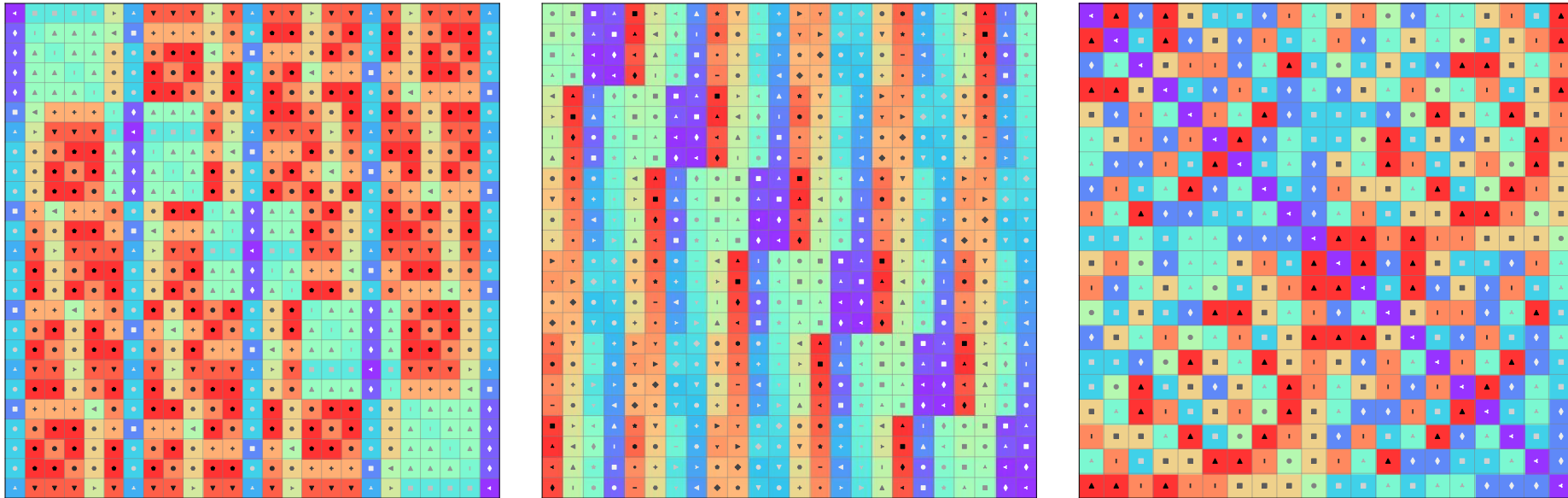
Efficiently* construct equivariant layers for any permutation group.



**linear* time complexity

Parameter-Sharing Library (AutoEquiv)

Efficiently* construct equivariant layers for any permutation group.



<https://github.com/mshakerinava/AutoEquiv>

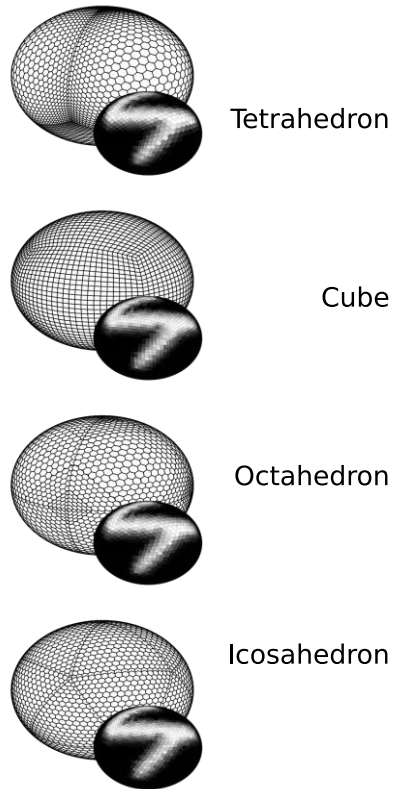
**linear* time complexity

Model Comparison on Spherical MNIST

Spherical MNIST: digits from MNIST projected on randomly rotated sphere

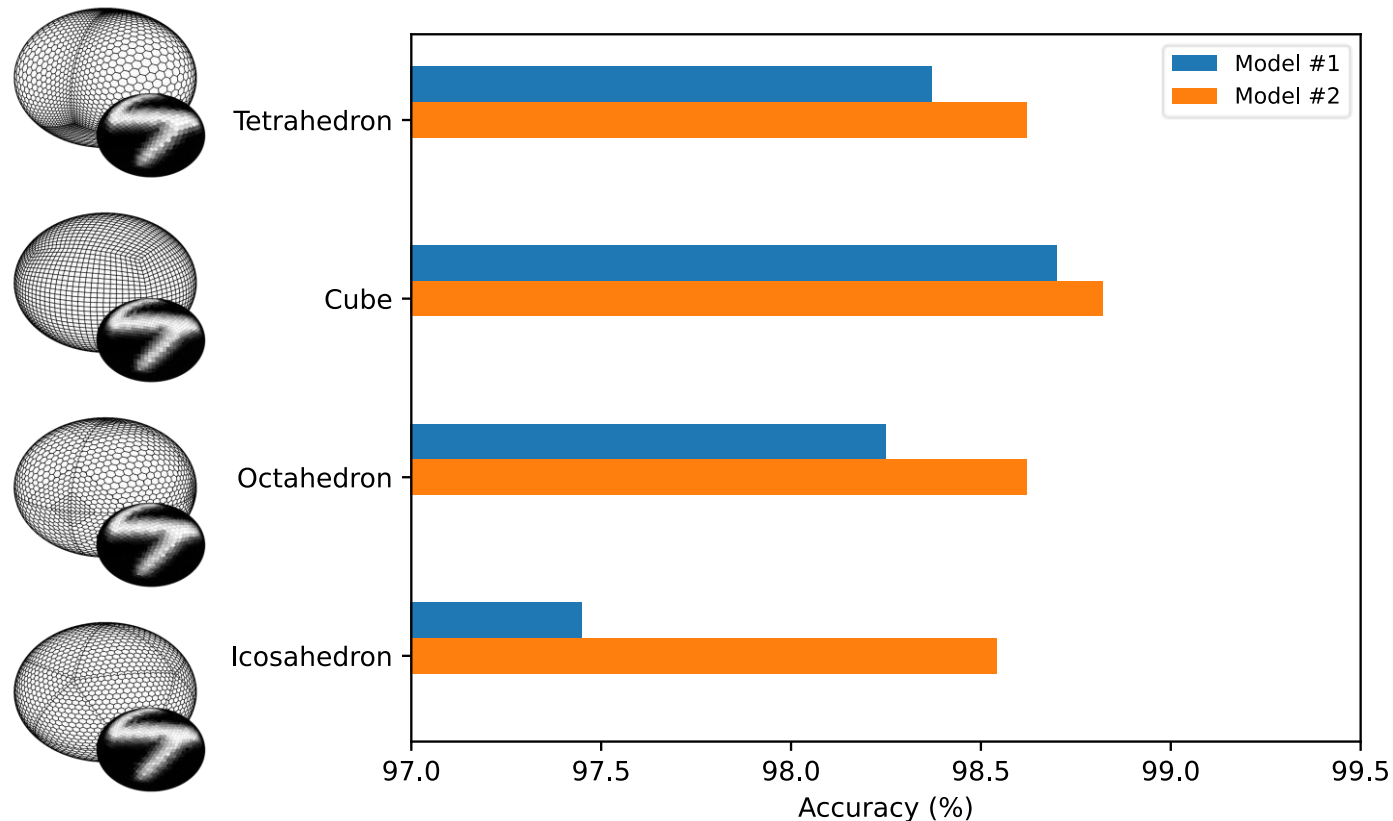
Model Comparison on Spherical MNIST

Spherical MNIST: digits from MNIST projected on randomly rotated sphere



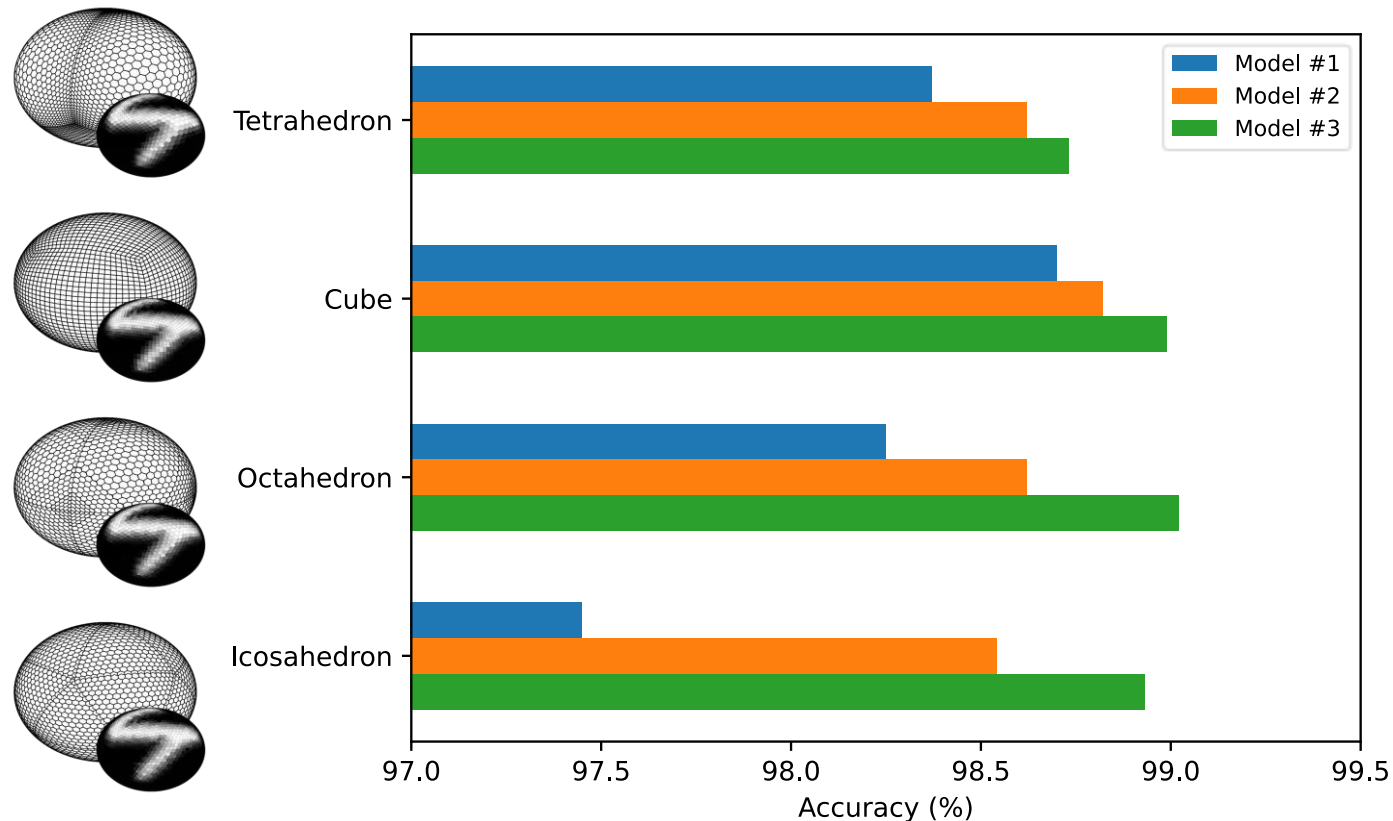
Model Comparison on Spherical MNIST

Spherical MNIST: digits from MNIST projected on randomly rotated sphere

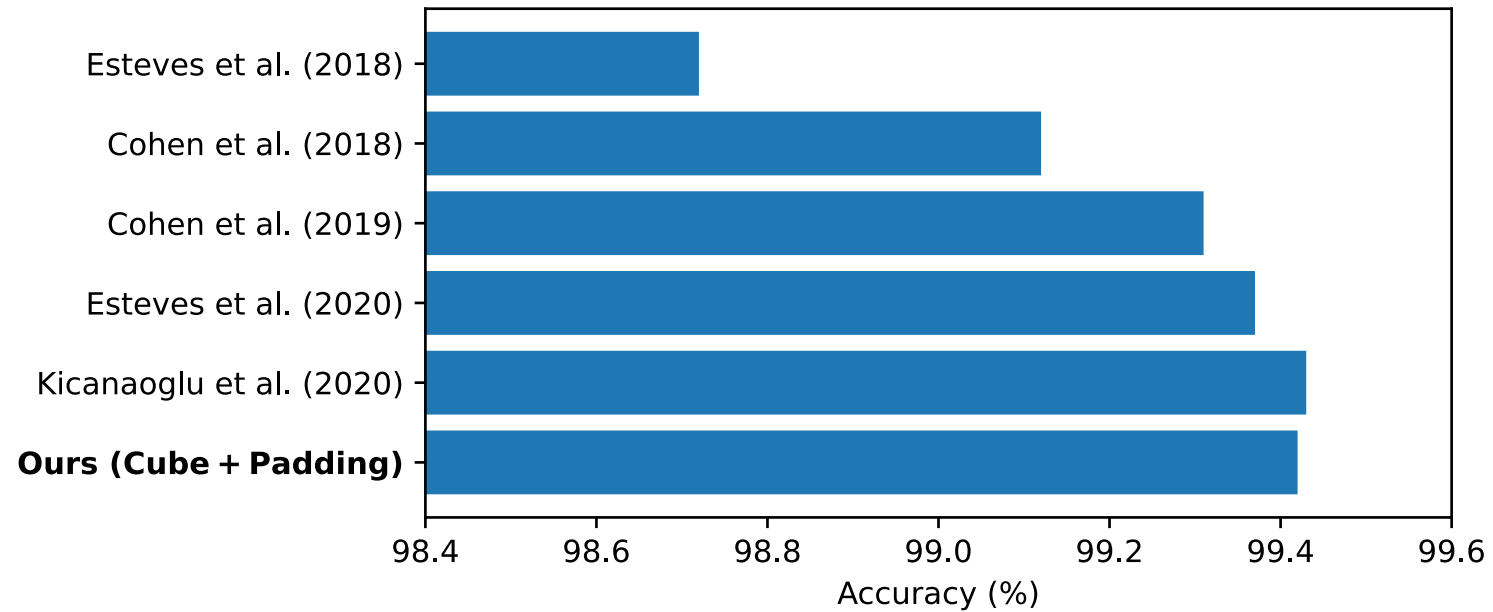


Model Comparison on Spherical MNIST

Spherical MNIST: digits from MNIST projected on randomly rotated sphere

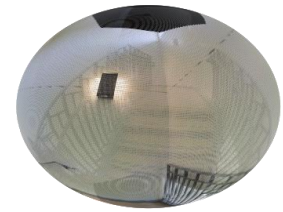
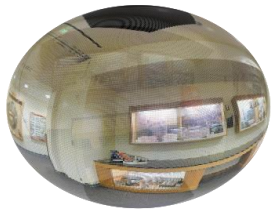


Spherical MNIST (Classification)



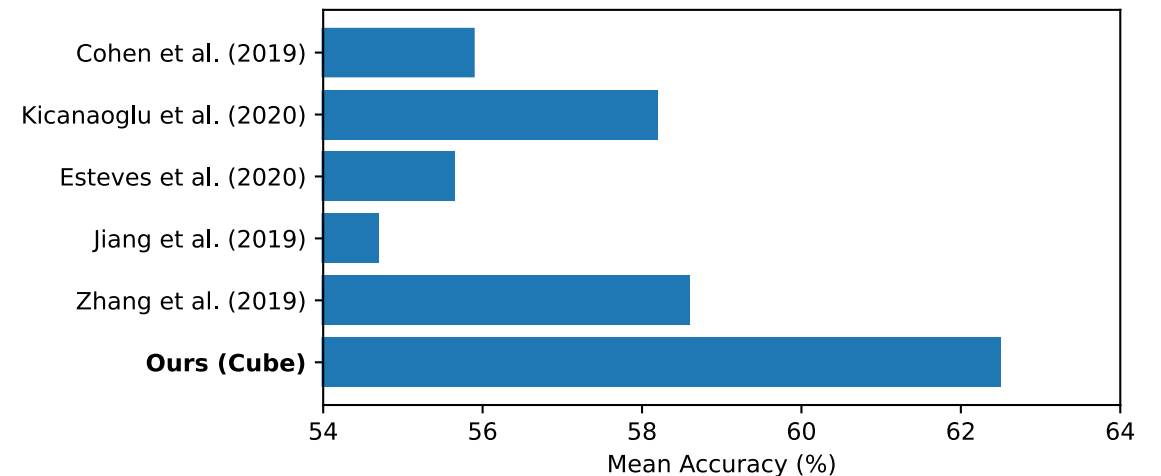
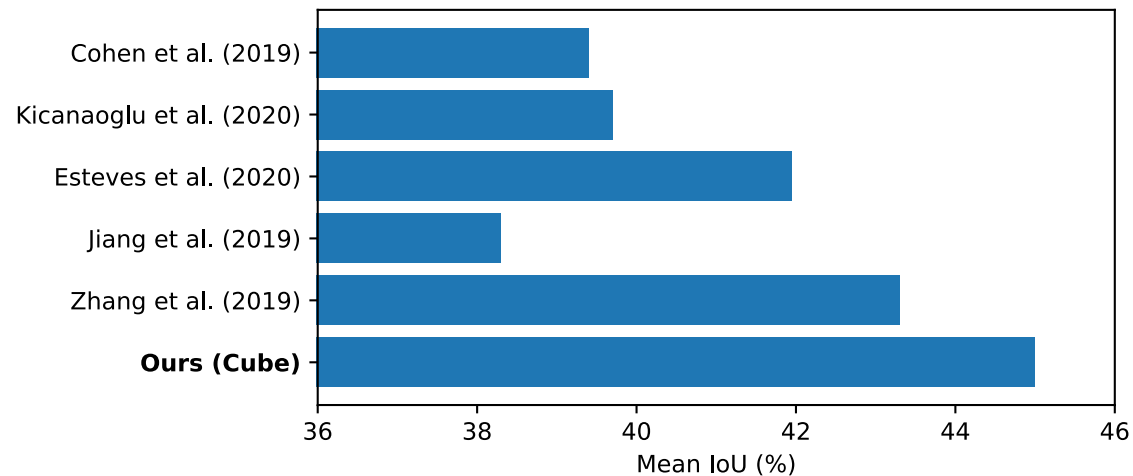
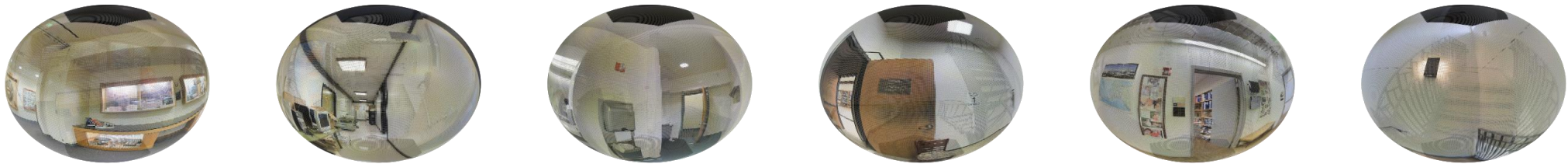
Stanford 2D-3D-Semantics (Segmentation)

Segment RGB-D images into 13 categories such as chair, table, ceiling, etc.



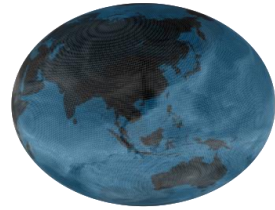
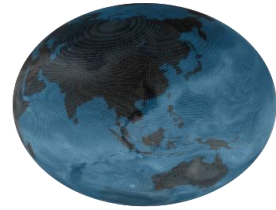
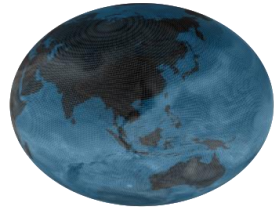
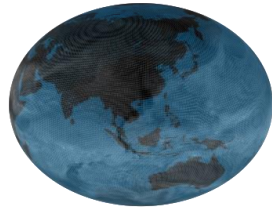
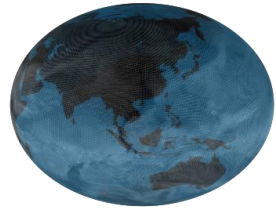
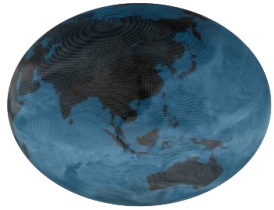
Stanford 2D-3D-Semantics (Segmentation)

Segment RGB-D images into 13 categories such as chair, table, ceiling, etc.



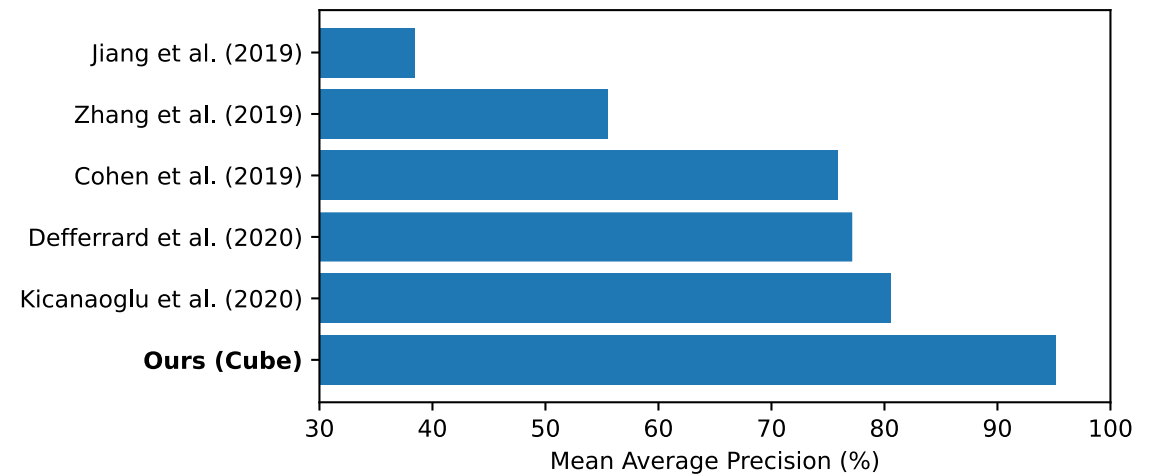
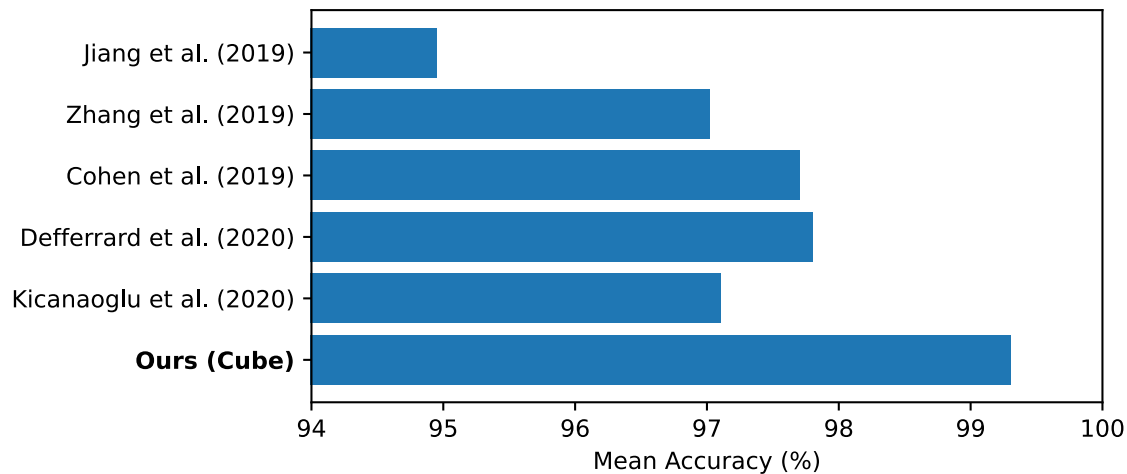
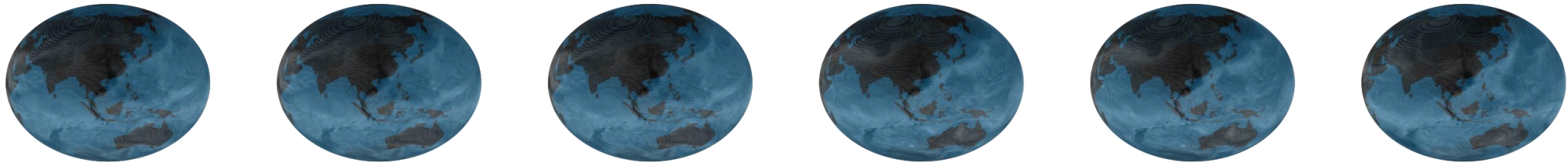
HAPPI20 (Segmentation)

Segment tropical cyclones and atmospheric rivers.



HAPPI20 (Segmentation)

Segment tropical cyclones and atmospheric rivers.



Thank you!

mehran.shakerinava@mila.quebec
mehran.shakerinava@mail.mcgill.ca