Google Research

Penn Engineering
GRASP LABORATORY
General Robotics, Automation, Sensing & Perception Lab

Cross-Domain 3D Equivariant Image Embeddings

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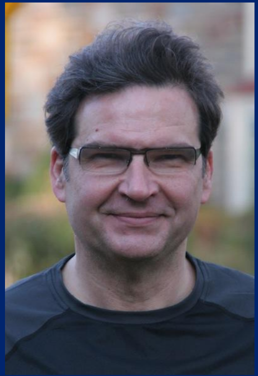
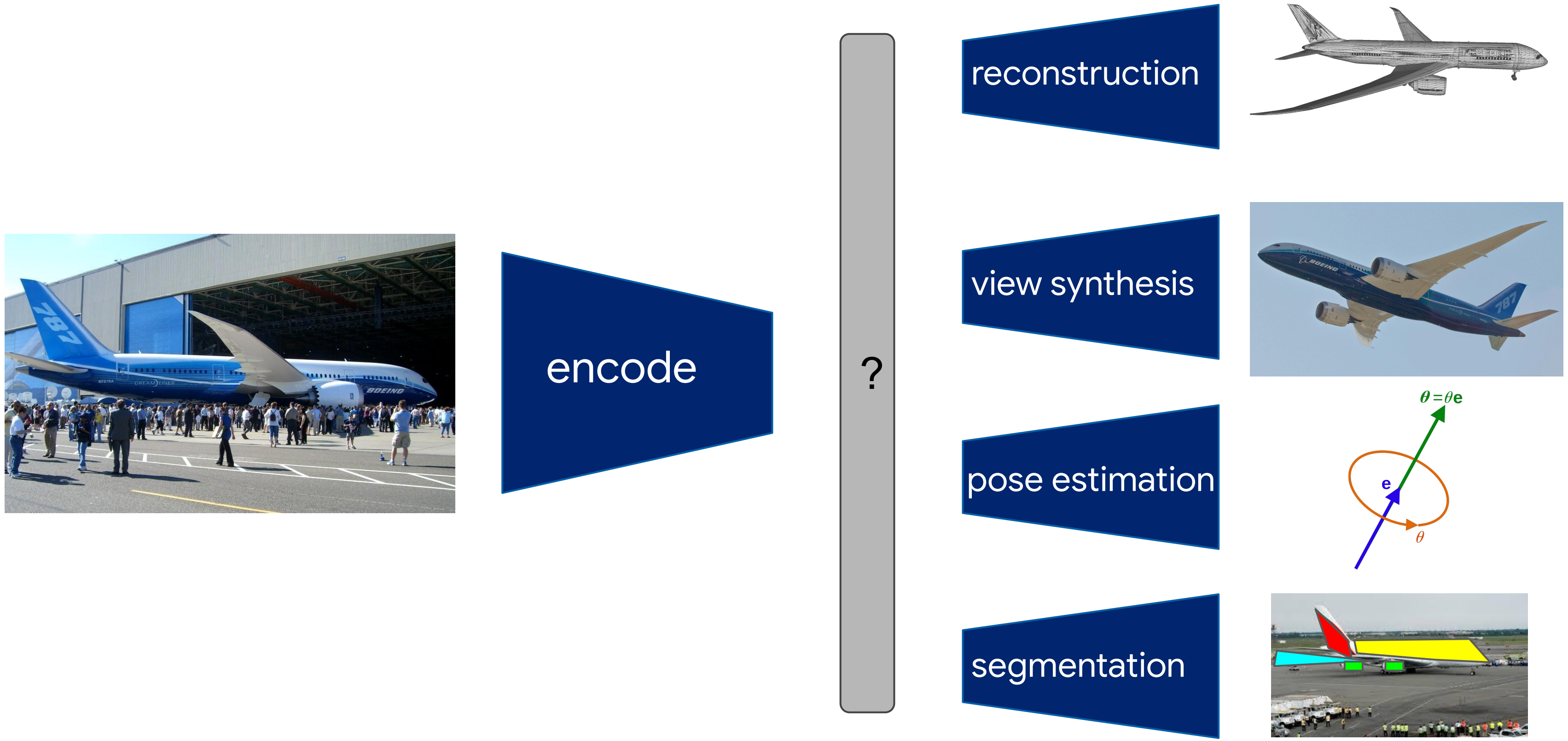


Ameesh Makadia

Universal image embeddings



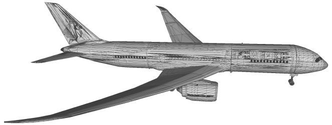
Images: Wikimedia commons (cc)

Why is this hard?

encode

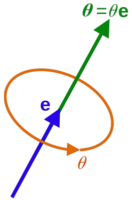
?

reconstruction

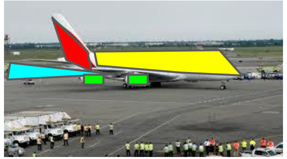


view synthesis

pose estimation

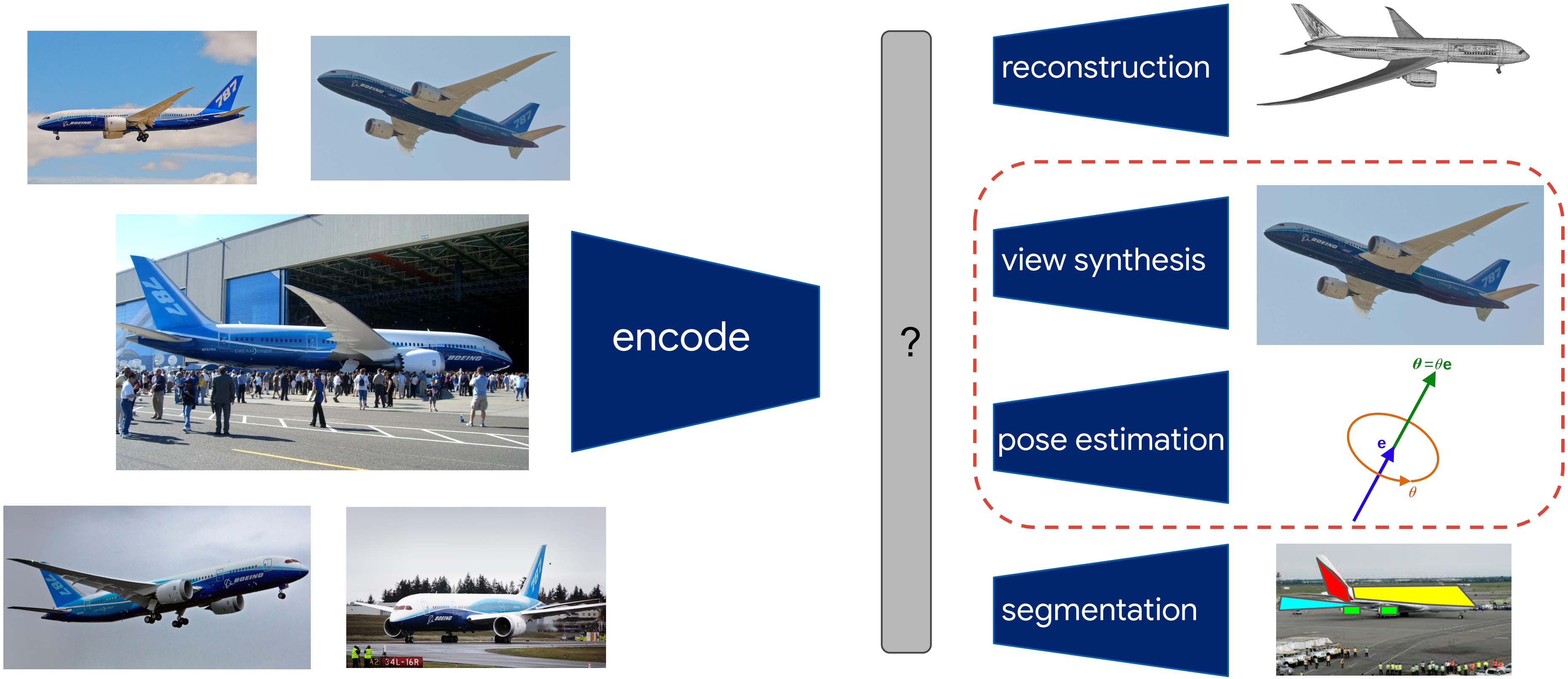


segmentation



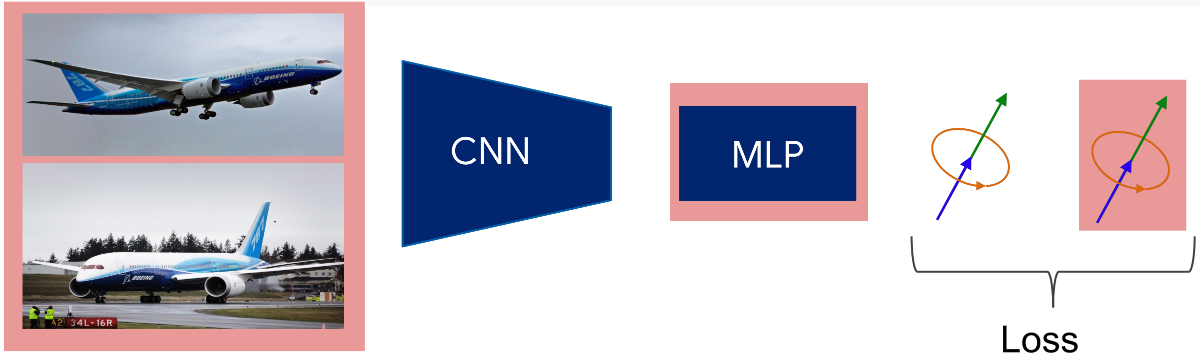
Images: Wikimedia commons (cc)

Why is this hard?



Images: Wikimedia commons (cc)

Conventional approaches



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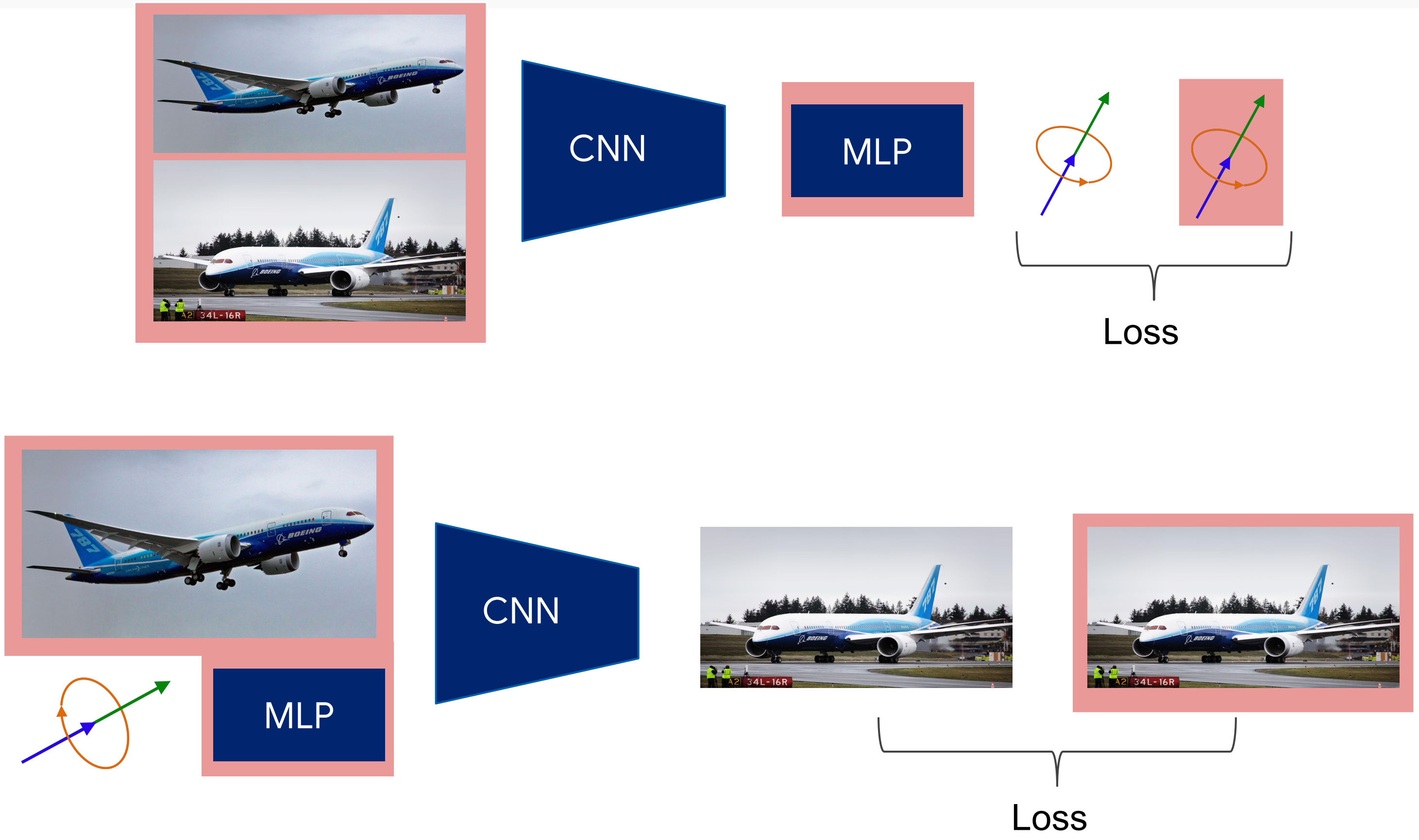
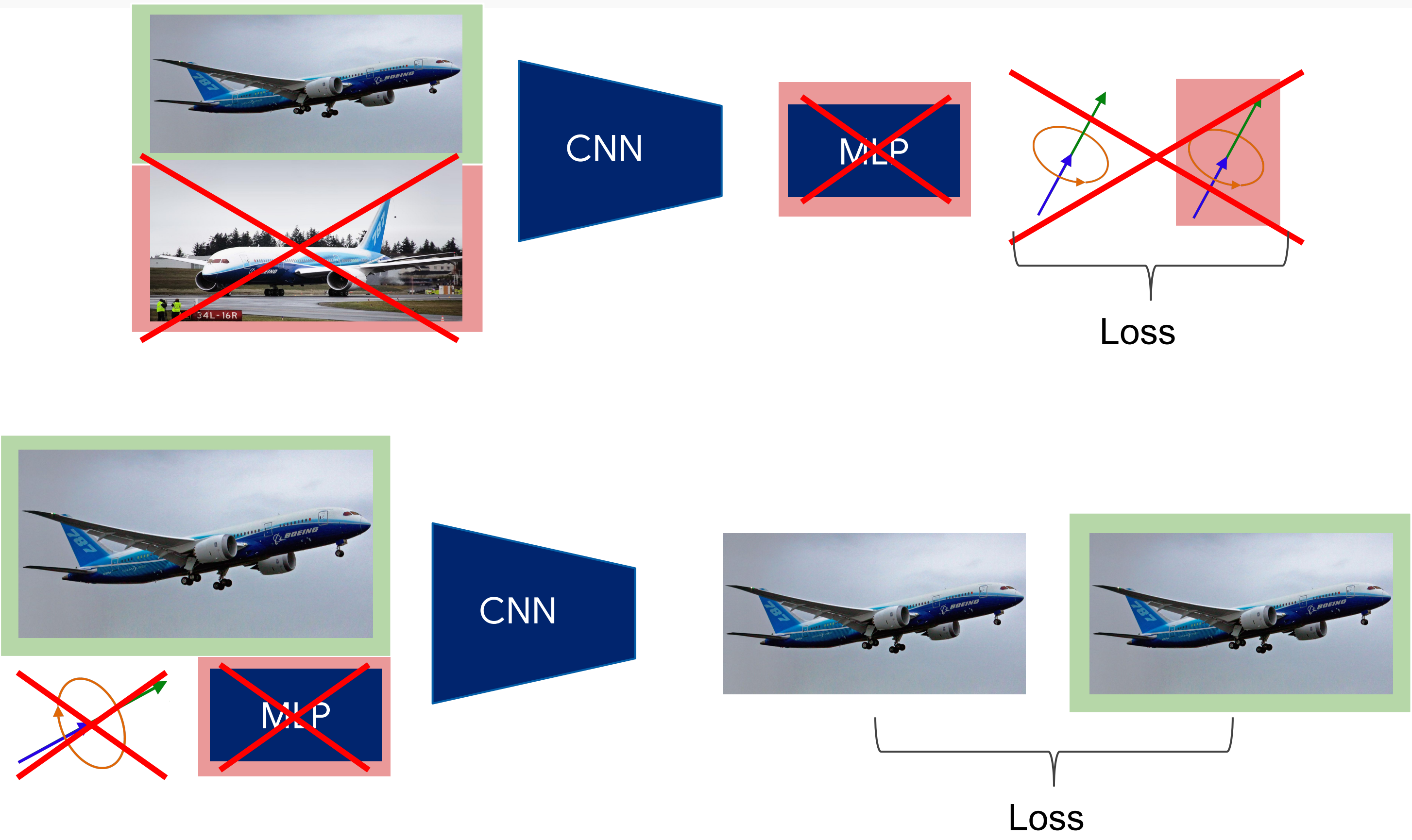
Conventional approaches



Images: Wikimedia commons (cc)

Our approach



Images: Wikimedia commons (cc)

3D equivariant embeddings

encode

?

Λ_R

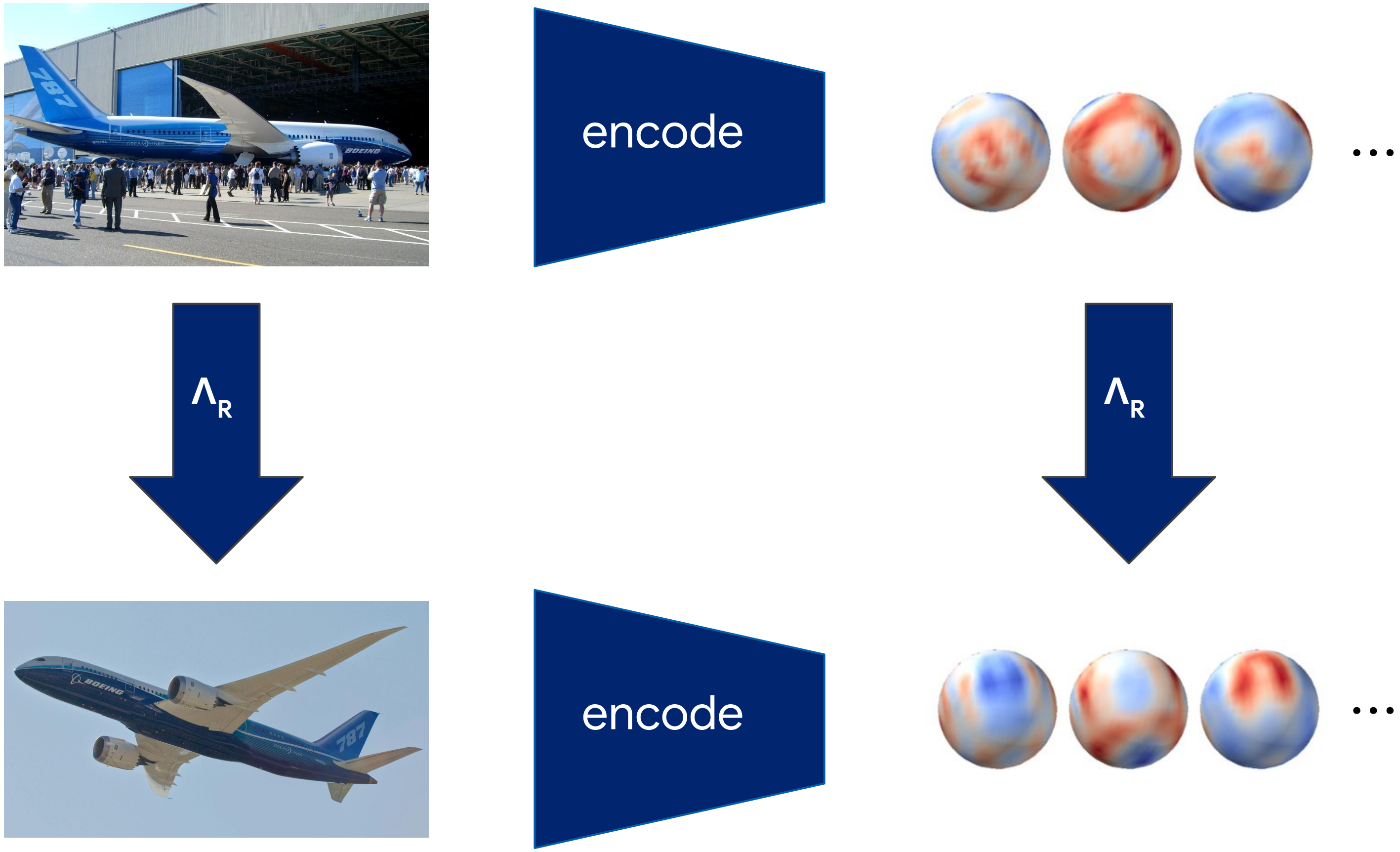
Λ_R

encode

?

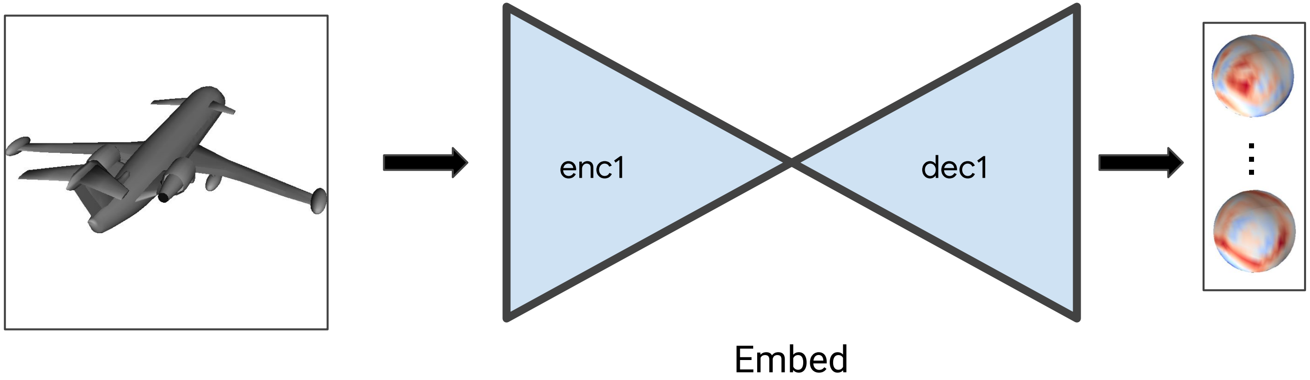
Images: Wikimedia commons (cc)

Embeddings on the sphere!

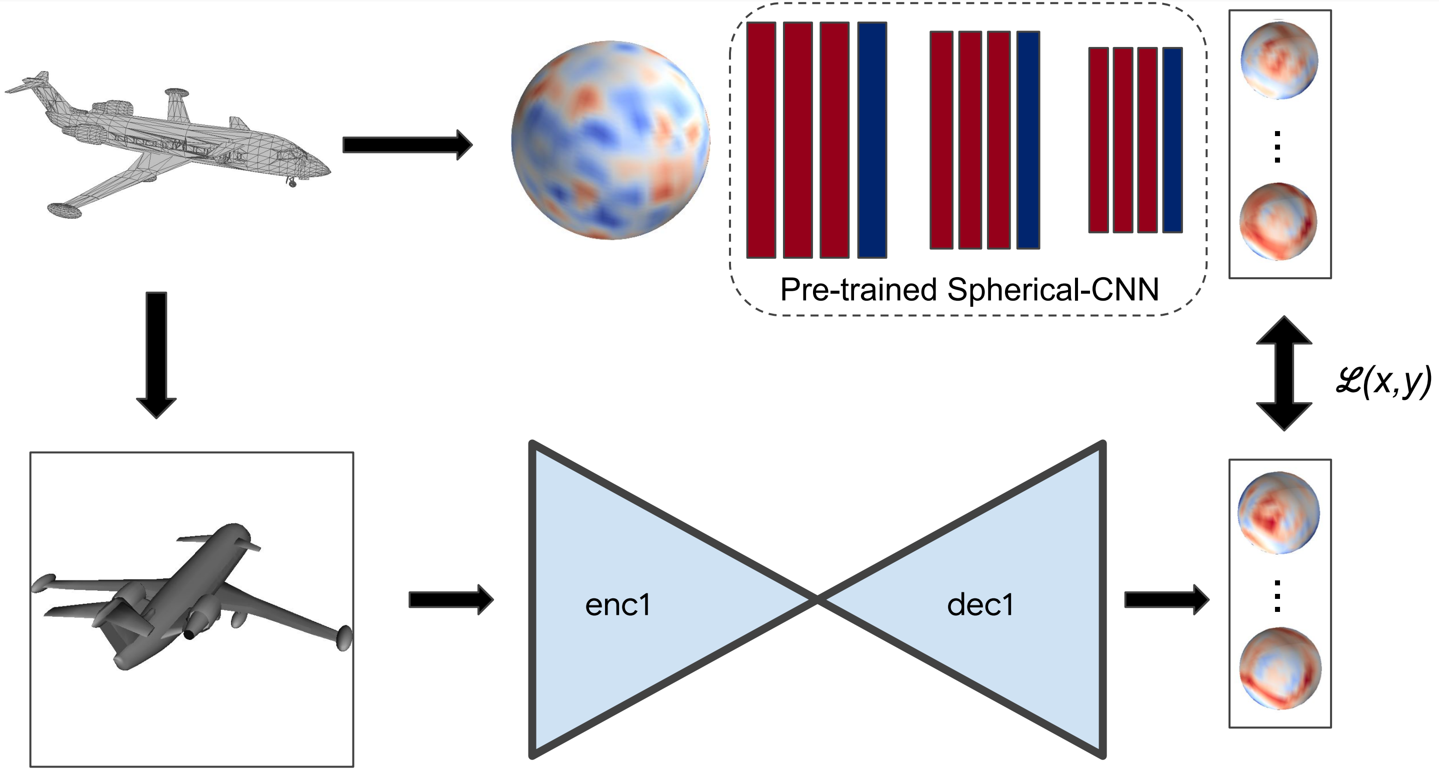


Images: Wikimedia commons (cc)

How to learn cross-domain embeddings?

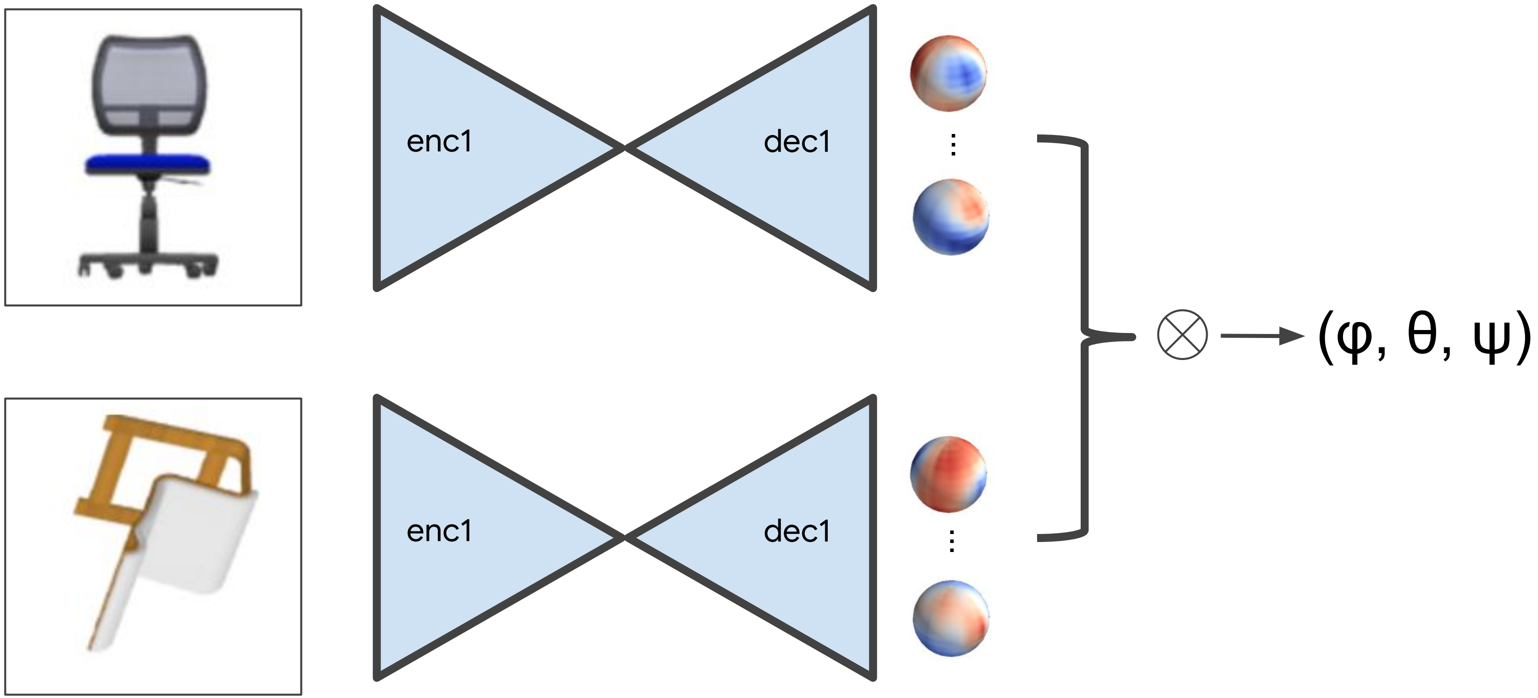


What is the supervision?



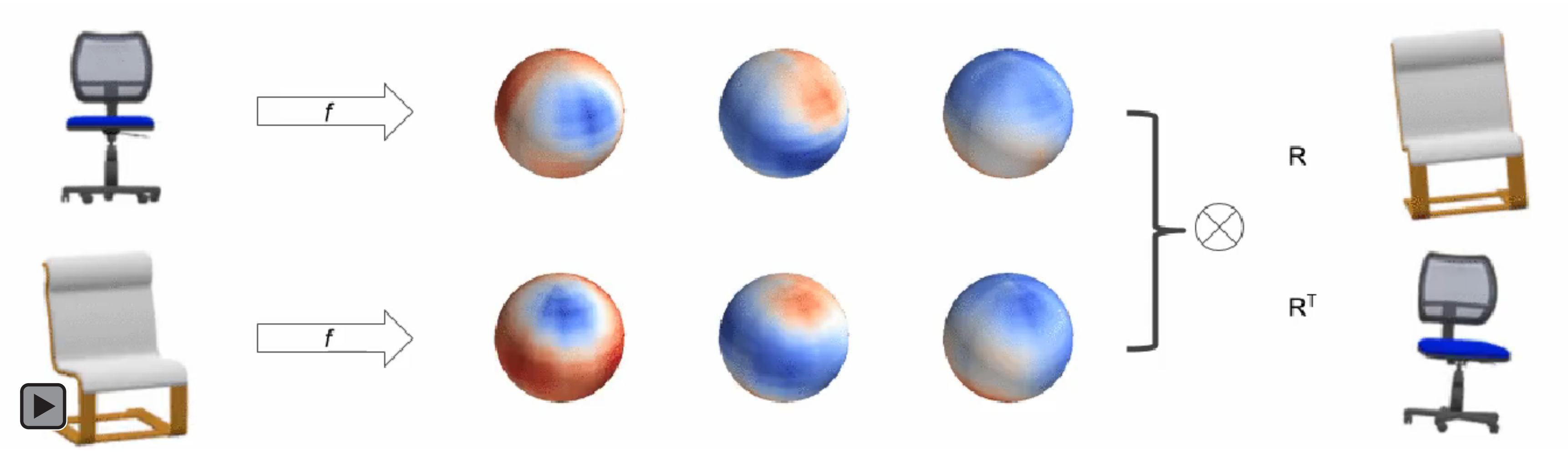
No task-specific supervision!

Relative pose estimation



No pose regression/supervision!

Relative pose estimation



Inputs

Embeddings

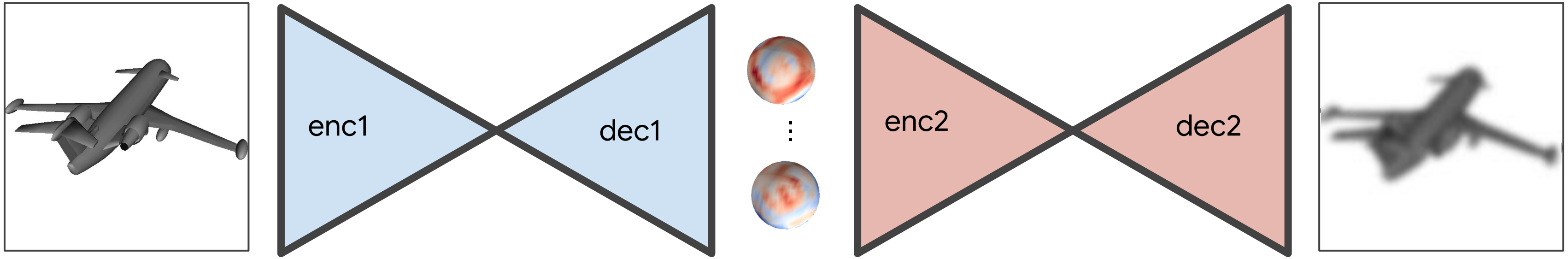
A to pose of B
B to pose of A

Results on real images from ObjectNet3D

Ours: **13.75 deg**, Regression: 36.52 deg (median error).

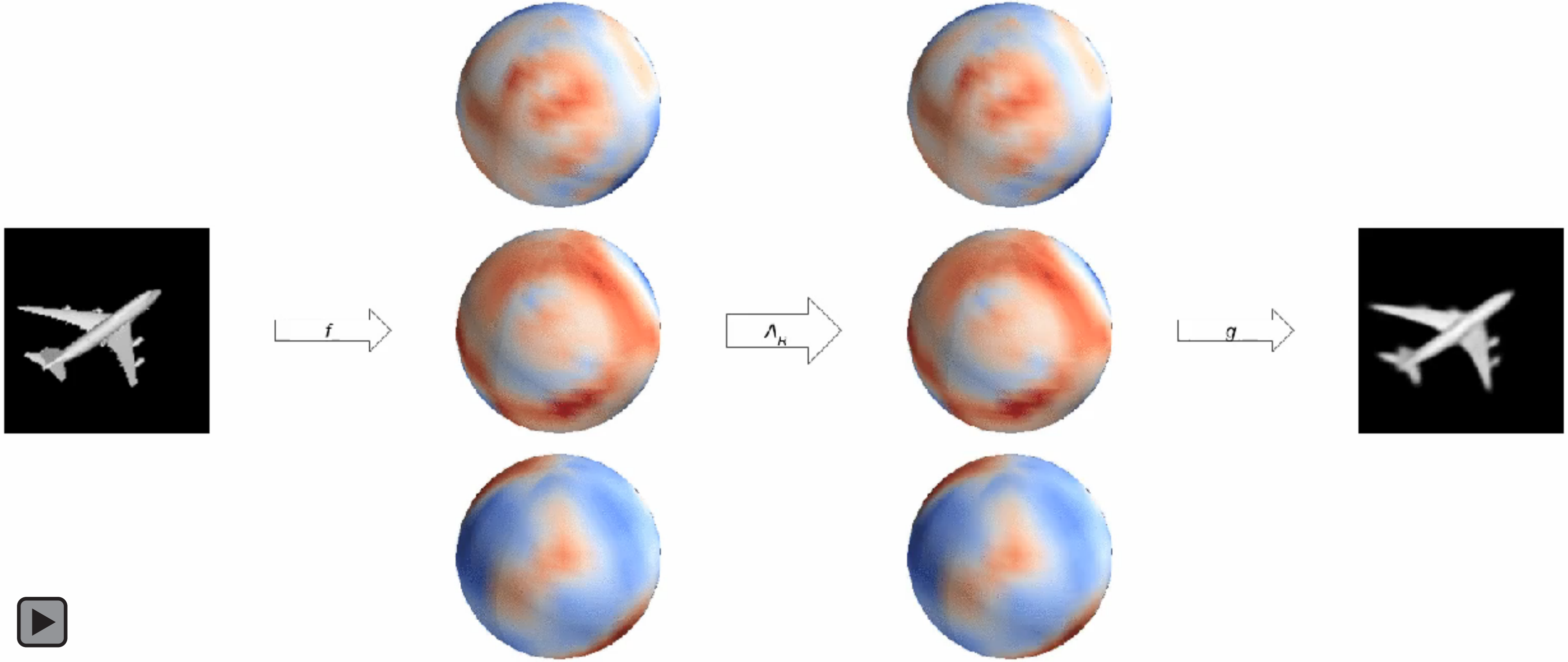
Dataset: Xiang et al. *ObjectNet3D: A Large Scale Database for 3D Object Recognition.* ECCV'16.

Novel view synthesis



Training time: reconstruct the input

Novel view synthesis



Test time: generate any view from any other view

Conclusion

A novel approach to learning geometric image embeddings

- equivariant to 3D rotations
- needs only unaligned meshes as training inputs
- generalizes to geometric tasks without typical task-specific supervision
  - e.g. no pose or view synthesis supervision
- avoids the difficulties of traditional approaches
  - e.g. no pose regression or full 3D structure prediction

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06:30 -- 09:00 PM @ Pacific Ballroom #25